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ERRATA.

Pages 39 to 56, in title, for "A. Hinrichs," read "G. Hinrichs."—P. 212, l. 3 from bottom, for "*Pinna*, and *Avicula Modiola*," read "*Pinna*, *Avicula* and *Modiola*."—P. 214, l. 14 from top, for "*M. perattennuata*," read "*M. perattenuata*."—P. 216, lines 17 and 22 from top, for "hinge in which," read "hinge of which."—P. 219, l. 14 from top, for "smooth, rounded," read "smoothly rounded."—P. 422, l. 1 from bottom, for "longifola," read "longifolia,"—P. 423, l. 7 from top, for "Loshii," read "Loschii."

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[SECOND SERIES.]

ART. I.—*Theory of Earthquakes;* by Professor ALEXIS PERREY, of Dijon, France.[1]

EARTHQUAKES are a complex phenomenon. It is difficult to refer them to one cause alone. The shocks or series of shocks in a given region may have a special or local cause. We may distinguish a number of such special causes acting independently of the principal cause whose general action they modify. Moreover, these secondary causes may be modified in their action by the principal cause, the latter manifesting itself only through a differential result.

Among the phenomena, it is difficult to distinguish those which are the effects of the principal cause from those of special or local causes. The first aim of investigation should be to determine that differential result in which the preponderating influence of the principal cause shall become manifest. For this purpose the comparison of a great number of facts is requisite. Before such a comparison, the local or anomalous influences disappear; or, in other words, the influence of the principal cause is brought into strong relief, the differential action making it manifest.

There is a periodicity as to times of occurrence in earthquakes, as in other cosmical and meteorological phenomena. When

[1] Translated for this Journal from a memoir communicated by the author entitled *Propositions sur les Tremblements de terre et les Volcans; formulées par* M. ALEXIS PERREY, *Professeur à la Faculté des Sciences de Dijon*, adressées à M. LAMÉ, Membre de l'Institut; 36 pp. 8vo. Paris, 1863. Mallet-Bachelier, Quai des Augustins, 55. Only the part on Earthquakes is here reproduced.

earthquakes, through a long period, are grouped with reference to the moon's age, two maxima and two minima of frequency may be distinguished in each lunar month, the maxima following immediately the syzygies, and the minima corresponding to the quadratures. When, again, they are grouped with reference to the passage of the moon over the meridian, there are two analogous maxima and two minima, the maxima corresponding to the passage of the superior and inferior meridian, and the minima to the intermediate times.

These laws, based, one on a comparison of more than 6000 days of earthquakes, and the other on a thousand of earthquake shocks, show that there is a relation between the frequency of earthquakes and the rotation of the moon. Is this relation one of cause and effect? I believe so, after a careful study of the subject, and propose to present the evidence.

Suppose the globe to have a fluid nucleus, incandescent, and either liquid or viscous, with a solid crust. Suppose, also, the thickness of the crust to be such that the outer limit of the interior mass be a spheroidal surface, similar to that of the exterior of the sphere. The moon will exert attraction on the central nucleus, and tend to give it an elongated form; and the opposite protuberant parts, formed under the lunar action, will tend to follow the line which connects the centre of the moon with the centre of the earth, as this line changes its position with reference to any fixed point on the earth.

Let us consider, first, the movement of the moon alone, leaving out of view the earth's orbital motion and rotation. The greater axis of the elongated central nucleus would then be directed constantly towards the moon. The two opposite protuberances would exert pressure against the interior surface of the crust, and would tend to change its form; and if the crust had but little thickness and were sufficiently elastic, it would at each instant take the form of the elongated nucleus. These successive changes of form in the solid crust could not take place without causing vibrations which should occur periodically, like their cause, nor without altering, at each place, the direction of the plumb-line which would pass periodically through the same positions. These two periodical phenomena have not yet been shown certainly to occur. Still a series of observation, made through several years by Mr. Airy, give us some reason to believe in their existence.

Suppose now the envelop or crust to have so great thickness and such elasticity that it cannot take at once the form of the central nucleus. Pressure and tension in the crust of a greater or less amount will be the result, which will be a cause of fractures. These fractures will be the starting point of molecular *vibrations which* may be propagated in the crust to its surface

and have the character of true *earthquakes.* Such is the first or principal cause of the phenomenon.

The two opposite protuberances of the central nucleus together constitute, in their movement of rotation, what we call the great or primary earthquake or seismic wave. The greater the lunar influence, the greater will be the protuberances and the higher the seismic wave.

The sun should produce an analogous effect during the progress of the earth in its orbit. From this, a second seismic wave should result, which, in the case supposed, would also cause, when its crests pass under the points of least resistance, the same kind of subterranean movement.

It is easy to conceive that in their simultaneous progress, these two seismic waves should add to, or diminish, one another, or coalesce in one wave, as with oceanic tidal waves. They will therefore manifest themselves at the surface only by their differential or their resultant effects; and their union will form the great luni-solar wave. Its effect will therefore be the greatest possible at the syzygies; and hence the ruptures of the earth, consequent thereupon, should be most frequent at these two epochs in the lunar period.

Let us now take note of the diurnal motion of the earth. We now have two new seismic waves; a lunar, the crests of which will change place under the meridian with the motion of our satellite, and a solar which will follow the course of the sun. Their effects on the inner surface of the earth's crust will be similar to those of the first two waves mentioned above; and the resulting diurnal wave may be regarded under the same points of view as the luni-solar wave depending solely on the motion of the moon in its orbit.

In their progress, these different waves are similar, or, at least, analogous, to those of the oceanic tides. They may be represented, in their movement, by a periodical function whose maxima and minima correspond to the maxima and minima of pressure on the earth's crust, which, supposing it homogeneous, will experience at these points maxima and minima in change of form, and consequently in frequency of fractures; and therefore maxima and minima in vibrations of the crust, or earthquakes.

Into these periodical functions of the seismic waves (or analytical expressions of the physical laws of the phenomenon) will enter necessarily the distances of the sun and moon from the earth. But the action being in the inverse ratio of the squares of the distances, the effect should be, under this point of view, greater at the perigee than at the apogee. In accordance with this, I have found, that, relatively to the lunar motion, earthquakes are more frequent at the perigee than at the apogee; and

relatively to the earth's orbital motion, they are more frequent at the winter solstice than at the summer, that is, at the perihelion than at the aphelion.

All these waves are, physically, not single waves, but are groups of successive undulations, like the tidal in the ocean. Hence there must be a succession of pressures and tensions in the passage of a seismic wave over a given point. Hence, also, a possible, and probable, succession in the vibrations of the crust. Hence, also, an undulatory character in the earthquake shocks, with alternations of intensity during their passage.

Thus far, we have regarded the crust as having interiorly an ellipsoidal surface, and the central nucleus as liquid or viscous. Let us now suppose the nucleus the same, but the inner surface of the crust as having irregularities like the outer,—that is, mountain elevations projecting inward, and immersed in the fluid mass, and valleys whose depressions are excavated in the crust. Such an internal orographic system would modify the progress of the seismic waves. A wave would rise and increase its velocity and, consequently, its active force, between two mountains or elevations that obstruct its passage; it would spread and lose velocity over a plain or in a valley where it could expand and develop itself; and would beat against the declivities or projections encountered. Hence a new kind of compression, and, therefore, of molecular vibrations, which should propagate themselves to the earth's surface, and appear as earthquakes. Hence also, beyond question, some partial displacements in the walls of the vaulted crust, and ruptures causing vibrations more or less intense. Hence, also, fissures in the vault, of greater or less extent, and more or less abrupt.

An introduction of the incandescent liquid from the earthquake-wave into these fissures could hardly take place without shocks or vibrations more or less apparent. But it is a question whether such vibrations would reach the earth's surface. This would depend on their intensity; and also on the thickness and elasticity of the crust, which would necessarily have an important influence.

These displacements and ruptures could not take place without sound.

Whether the ruptures be a result of the alteration of the form of the crust, under the pressure of a passing seismic wave, or of the shock of a wave against an internal protuberance, or of the contraction of the liquid material on its cooling after it has entered a fissure, or of any other cause, they must always be accompanied by vibrations; and these vibrations would propagate themselves to a greater or less distance, according to the condition and nature of the region.

But are these fractures, as has been said, the only cause of the sounds which so often precede, accompany, or follow, earthquakes? It is difficult to believe it. We acknowledge that we are not ready to explain the sounds that so often precede earthquakes. In the case of earthquake shocks which are continued for a length of time, these sounds are often repeated: And how does the sound-vibration differ from the dynamical vibration which immediately follows it? Moreover, in such earthquake-shocks, continued for a length of time, both aërial and subterranean detonations are frequently repeated without any sensible movement of the ground. Many instances of this kind occurred in the valley of Visp in 1855 and 1856.[1] The sounds are, in fact, one of the most obscure elements connected with earthquakes.

But to proceed, the ruptures which take place at certain points in the crust shake the neighboring parts, which, in their turn, under the action of successive earthquake waves, lead to other like fractures. Such catastrophes may again and again follow. We thus account for the shocks which are repeated for a greater or less time after every great earthquake.

The fractures opened at any point will become prolonged in the direction of the line of least resistance. Hence comes the change in the centre or focus of principal disturbance, which is often noticed in the course of a long series of shocks.

The introduction of the liquid material of the earth's centre into the fissures is not always effected instantaneously. It may require more or less time; and the vibrations thus caused may take place after the passage of the earthquake-wave. Hence come perturbations in the periodicity of the phenomenon.

It follows from these views, that earthquakes should have their greatest regularity of march and greatest frequency in a certain equatorial zone more or less wide; and outside of this zone, similar effects should be produced, proportioned in intensity to the different earthquake-waves, derived or reflected. But it is seen that the waves that are propagated laterally arrive later, relatively to the passage of the moon over the meridian, at the places where the derivative currents go.

When these derivative or reflected waves, in any case, produce fractures, followed by vibrations which continue for a length of time, we should have a prolonged shaking of a region in which, otherwise, the phenomenon is of rare occurrence. Examples of this kind are the shocks on the Mississippi in 1811; those of Maurienne in 1838; those of Scotland in 1842 and 1843.

[1] The detonations in the valley of Visp continued to occur at intervals even till May, 1861. The later months of the year do not appear to have been marked by any repetition of the phenomena of 1855.—(Letters and Journal of M. Tscheinen, curate at Græchen.)—Note added August 26th, 1862.

The periodicity of the phenomenon may manifest itself again in the renewal of the shocks. But the maxima and minima of frequency will not correspond with the passage of the principal seismic waves. The order may even be wholly reversed. It is a phenomenon analogous to the "establishment of the port" in the oceanic tides.

The physical law, that earthquakes are more numerous at the syzygies than at the quadratures, is one that is verified by simply counting the days of earthquakes during a sufficiently large number of years. This I have done for a period of 50 years, from 1801 to 1850,[1] and also for each half of this period. Again, dividing these 50 years into 10 periods of 5 years each, I have detected two maxima and two minima in nine of these partial periods. In seven, the maxima has occurred at the syzygies and the minima at the quadratures; in two the reverse has taken place. The principal, above pointed out, of the establishment of the port is alone sufficient to explain this apparent anomaly. In these two 5-year periods, there was a series of local shocks in a region where earthquakes are unfrequent.

The quinquennial period from 1810 to 1815 affords no sensible maxima and minima. But the facts on record are few. During the unhappy years of 1814, 1815, the journals took little note of subterranean commotions.

[1] Prof. Perrey has made out, from the facts which he has collected, for the first half of the present century (from 1801 to 1850), that there were 5388 lunar days on which earthquakes occurred; or, counting as so many separate days, where 2 or 3 or more earthquakes occur on the same day, but in distant countries and wholly independent, (the most correct method for his calculations,) 6596 lunar days. In order to refer these days to the syzygies and quadratures, he divides the mean lunation of 29·53 days into 8 equal parts, and then groups these into 4, by uniting the 1st and 8th and 4th and 5th, for the new and full moon or syzygies, and the 2nd and 3d and 6th and 7th for the quadratures.

Arranging thus the phenomena, he obtained for the 5388 days,—2761·48 at the syzygies and 2626·52 at the quadratures, leaving a difference in favor of the syzygies of 134·96.

For the 6596 days, he obtained 3434·64 at the syzygies and 3161·36 at the quadratures, leaving 273·28 in favor of the syzygies.

In a similar manner, for the half century preceding, or from 1751 to 1800, he obtained 1901·18 earthquake days at the syzygies, and 1753·82 at the quadratures, the difference in favor of the syzygies being 147·36.

Counting the earthquake days during the years 1761 to 1800, which occur within the period of five days, from the second day before the apogee and perigee to the second day after inclusive, he found 526 earthquake days at the perigee and 465½ at the apogee, leaving a difference of 60½ in favor of the perigee; or leaving off the outer two of the five days, the result was 313½ at the perigee and 278½ at the apogee, or an excess of 35 at the perigee.

Taking the earthquakes of Reggio in Calabria as given for the years 1836 to 1853 (18 years) in a Journal kept by M. S. Arcovito, he finds 437 earthquake shocks at the syzygies and 349 at the quadratures, or an excess of 88 at the syzygies. He also obtains, for the number of shocks when the moon was less than 45° from the meridian 413, when more than 45°, 347, leaving 66 shocks in favor of the former.—See for a fuller statement of these results, and additional facts, *Comptes Rendus*, lii, *146-151, Jan. 28, 1861.*

We have above supposed the central nucleus of the earth to be in an incandescent state, either liquid or viscous. But can this be without the existence of intense chemical action proportional to the high temperature of incandescence? Under such circumstances would there not be electro-magnetic currents? May it not be that, through the influence of such currents, which Dr. Ami Boué makes the first cause of earthquakes, and also under that of the various chemical actions going on, gases would be developed so as to form a more or less continuous atmosphere between the central nucleus and the crust? And should not the presence of these gases modify in some way, the dynamic action of the earthquake waves? Is not their sudden explosion, the cause, at times, of transient disturbances in the central mass? And, consequently, are there not thence sensible reactions against the inner surface of the crust, causing strong vibrations that are propagated to the outer surface?

This idea, which I have elsewhere brought forward,[4] is remarked upon as follows by the learned author of the *Histoire des Progrès de la Géologie.* "As to these immense tempests which the author raises at the surface of the incandescent fluid, whose waves of fire beat against the flanks of the mountains which project downward like gigantic stalactites, they appear to us to be a little remote from the domain of science and to pertain rather to that of the imagination."

But, without taxing too much the imagination, can we not see that these chemical actions, which others have made the sole cause of earthquakes, may produce some perturbations, or modifications, in earthquake movements which shall obscure at times the periodicity?

Formerly, especially during the last century, the existence of numerous vast caverns in the earth, for the propagation of earthquakes, was admitted. We do not deny the existence of such caverns; but, in our view, instead of their favoring earthquake vibrations they would arrest, or at least impede, them. The simplest break will modify the rate and direction of the undulations. But such caverns should also cause, in some cases, molecular vibrations which, on being propagated to the earth's surface, would not differ from ordinary earthquakes. The liquid matter, in entering the cavities, would also cause shocks of a similar kind. Hence may come some of those facts registered in earthquake tables, which interfere with the exhibition of the periodicity.

We pass by other causes to which earthquakes have been attributed. Several, although less general than they have been supposed to be, may be admitted among special or secondary causes.

[4] Memoir on the earthquakes of the Scandinavian peninsula, *Voyages de la Commission Scientifique du Nord en Scandinavie, en Laponie, etc.*, Paris, 1845.

It cannot be too often repeated, that earthquakes are not of one single kind, identically the same. They are various both in causes and effects; I aim simply to bring out in relief the principal cause. I seek to establish its truth, by the differential influence manifested in its march as regards time.

As to the geographical relations of earthquakes, I say only, that no region is secure from subterranean movements; and that no geological formation is exempt; but that the mountain systems of the surface appear to exercise a great influence at least on their propagation if not on their frequency. The vibrations are usually propagated along the main axis of a chain; as has been observed in the Pyrenees and the Andes. In the great valleys occupied by rivers, the mean direction, as calculated by Lambert, appears to be that of the course of the depression. I have shown this to be the fact with the basins of the Rhone and the Rhine, where the direction is nearly meridional, and the basin of the Danube, which has a transverse course, or from west to east.

In France, the departments most subject to earthquakes appear to be those about the mouths of the large rivers. The department of the Isère, where the depression of the valley of the Rhone forms a kind of node with that of the Saône, is the only one which can compare with the kind just mentioned in number of earthquakes.

It is a question whether or not a double orthogonal curvature in the outer surface indicates an analogous structure through the whole thickness of the crust; and whether or not a structure of this kind presents less resistance to the propagation of shocks.

Whatever may be the cause of the molecular vibration at any given point in the crust, vibrations will be propagated in the form of waves; and in a homogeneous medium, the waves will be spherical and concentric. How will it then be in a medium which is not homogeneous, or is of unequal density? This cannot be decided without investigation.

In the case of the propagation of a series of waves which succeed one another through each point in the sphere of undulation and make successive shocks at the earth's surface, the shocks directly over the centre or focus of the vibrations will be vertical: and the obliquity, or variation from verticality, will be greater the more remote the place of emergence at the surface is from the centre of vibration alluded to; or, the locality being fixed, the nearer this centre is to the surface.

There can be no rotary shocks; the cases of apparent rotation we have explained elsewhere. But does the direction of a shock indicate the point from which it actually comes? I believe not. The difference in the rocks encountered should produce *derivative and reflected* undulations, as in the case of waves of sound.

Breaks in the rocks, as the caverns referred to, must modify their propagation, vary their direction and weaken their intensity, and may extinguish them; and this may account for the simultaneous shaking of two regions while an intermediate locality is undisturbed—a phenomenon of so frequent occurrence in certain parts of America that the people speak of it under the expression of the earth being *bridged within*, or *suspended.*

Boussingault recognized, as the principal cause of the earthquakes of the Andes, the continual and progressive sliding of the dislocated rocks of which they consist; and he considered the phenomenon as incessant in South America, an earthquake taking place, in his view, somewhere in the Andes at every instant of time.

These views are not at variance with my own. Any slidings due to gravity will be caused, or favored, by the daily vibrations whose effects and causes have been considered.

Calculation demonstrates the existence of two kinds of waves moving with different velocities around a centre of vibration; I admit readily, with Mr. Wertheim, the coëxistence of these two kinds of waves. If then there are several successive sets of vibrations at a given point, each will propagate the double system of waves. It will be the same, also, if there are simultaneous disturbances at a number of neighboring points. The waves of greatest velocity of one set will overtake and pass by those of least velocity in the preceding set, and at an interval of distance depending on the interval of time between the successive vibrations.

The ingenious idea that two species of waves or undulations pertaining to two successive sets of vibrations may produce at the surface of the earth one vibration of combined intensity, has nothing in it to which I can object. It is analogous to the interference of waves of light. We also admit, with Mr. Wertheim, that two such combined waves may occasion greater violence of disturbance than the passage of two successive waves. In this case, the surface of the earth under vibration, if perfectly homogeneous, should present concentric zones in which the disturbance will be alternately more and less great. I would say, however, that I do not believe that such an alternation of effects from earthquakes has ever been observed. For such results, not only would a uniformity in the earth's crust be required, but also the structures on the surface to be upset or damaged should have an identity of construction and of position with reference to the points of compass which cannot be looked for.

At some future time, I propose to consider, from this point of view, the occurrence of the first shock more or less light which precedes often the great shakings, and of the harmless vibrations which separate the disastrous shocks; and also the short interval

of relative repose or simple tremulousness which separates two consecutive shocks of moderate intensity.

As to the velocity of the propagation of shocks, we make no definite statement. Notwithstanding the trials of Dr. Julius Schmidt, we have no confidence in the results derived from his calculations, believing that they are based on too uncertain data.

The methods proposed by Mr. R. Mallet, will we doubt not, if carried out, give an exact determination of this element in the phenomena of earthquakes. We recognize the importance of the problem. But even if the means of noting time should be much better than at present, and in more general use, it may be doubted whether numerical results will be obtained of much value to science.

ART. II.—*The Classification of Animals based on the principle of Cephalization;* by JAMES D. DANA.—No. II. *Classification of Insects.*[1]

THE principles which have been presented in my former article on the classification of animals may be further exemplified by a discussion of the natural system of classification in a few subdivisions of the animal kingdom; and at the present time I take up for this purpose the order of Insects.

The subject may be appropriately introduced by a recapitulation, arranged so as to be convenient for reference, of those of the characteristics bearing on grade which are of most prominent importance. In connection with the mention below of these characteristics, the number of the page is added on which they are explained and illustrated in the preceding volume of this Journal. Other characteristics not here enumerated will be found on the pages referred to.

Under each head the characteristic to be looked for in a *superior* group is first mentioned; and then those of related kinds in *inferior* groups.

I. In a *superior* group, (A) a *prosthenic* condition. In an *inferior* group (B) a *metasthenic* condition of different grades or kinds; or in a still lower group (C) a *urosthenic* condition. (P. 323.)

These conditions come under the *transferent* method of cephalization, which is exhibited in a transfer of force and function towards the head (preferent) with ascending grade, or in the reverse direction (retroferent) with descending.

This transfer is similar in nature to that which results in *amplificate* forms and the reverse; in one direction, the descending, it is *outward* or

[1] *For* Article I, see last volume of this Journal, p. 321.

circumferential diffusion, and may be designated *apocentric;* in the other, the ascending, it is *cephalic concentration* or *epicentric*—the systemic centre here referred to corresponding in position to the cephalic nervous mass or brain (p. 322).

The degrees of concentration do not generally shade indefinitely into one another. There is a range of variations under a given type or specific condition of the systemic force; and then a drop-down or *saltus* to another typical grade, or condition. Such conditions, in all probability, have specific mathematical relations, like other conditions of force in nature, (as in chemistry,) although science may never succeed in giving them a written expression.

II. In a *superior* group, (A) compactness, regularity and perfection of structure, with normal proportions and narrow limits of variation.

In an *inferior* group, (B) a condition of inferiority in general structure, attended with a wide diversity of form and size, and sometimes bizarre shapes; (C) an *amplificate* condition, manifested either in a widening of the structure (broad-amplificate), or in a lengthening of body anteriorly and posteriorly (mostly the latter), or a lengthening or attenuation of limbs (long-amplificate), or in a general enlargement (large-amplificate, gross-amplificate); (D) a *multiplicate* condition, or an indefinite multiplication of segments or members, as in Myriapods and Worms, and opposed to a *limitate* condition like that of Insects, Spiders, and Crustaceans; (E) an *analyzed* or *elementalized* condition, being a more or less complete resolution into elemental segments or parts, each more or less nearly of normal equality; (F) an *elliptic* condition exhibited in either a diminution of size of parts or members, or of number of segments, organs or parts, through abnormal weakness of the life-system, and manifested especially in inferior or degradational species. (Pages 324–328, 337, 440.)

III. *Sup.*, (A) a highly *differentiated* condition of structure corresponding to highly specialized or subdivided functions.—*Inf.*, (B) a *simplified* condition, or one less specialized in functions and therefore less differentiated in structure. (P. 327.)

IV. *Sup.*, (A) a *perfunctionate* condition of any organ or part, that is, one in which an organ is characterized by its highest normal functions. *Inf.*, (B) a perverted condition of an organ, or a prostitution of it to other than the normal function; (C) a more or less completely *defunctionated* condition of any organs or members. (P. 324.)

V. *Sup.*, (A) a *terrestrial* mode of life in all stages.—*Inf.*, (B) an *aquatic* mode of life, (*a*) in the adult stage, but not connected with aquatic respiration; (*b*) in the larval stage only; (*c*) in all stages, with aquatic respiration throughout each. A terrestrial mode of life in all stages may be distinguished as *perterrestrial;* and an aquatic mode of life in all stages with aquatic

respiration, *peraquatic*. The latter has been observed on page 330, (Art. I.) to have a *dilutive* effect on the materials and powers of growth; and the effect is similar, though less extreme, or *semidilutive*, when only the young stage is *aquatic*. (P. 330.)

VI. *Sup.*, (A) *permaturative* in development: of which there are two grades in Insects—the higher (*a*) when the larve is imperfect in its mouth-organs and nearly or quite foot-less; the lower (*b*) when it has large mouth-organs and is locomotive and active. Condition *b* distinguishes the lower subdivision of Hymenopters, and *a* the other species. Condition *a* may occur in inferior grades, as among Coleopters, apparently through degradation.—*Inf.*, (B) *prematurative*, or passing through no period of rest in the young state, as in Insects undergoing no complete metamorphosis. (P. 328.)

VII. *Sup.*, (A) *holozoic*, or strictly and wholly animal in type, being neither radiate externally or internally, nor attached, nor having the power of budding.—*Inf.*, (B) *hemiphytoid*, either in (*a*) having the faculty of budding, or (*b*) in being attached, or (*c*) in being radiate externally but not internally; (C) *phytoid*, being radiate internally—either (*a*) this alone, or (*b*) this in addition to the budding function, or (*c*) in addition to being attached. (P. 327.)

VIII. Besides the above there are cases among the higher groups which exhibit in the transition to the group next below a strongly marked *general lowering of grade of structure and potentiality*, but not the prominent characteristics of any one or two of the special methods of decephalization. Sometimes it is accompanied by a fundamental change in plan of structure, but not in accordance with any of the methods enumerated, it being of a more profound character.

The distinction between Megasthenes and Microsthenes under Mammals is of this kind (p. 338); also that of Mammals and Birds; also that of Insecteans and Crustaceans among Articulates. In the last, there is not only a change from terrestrial to aquatic life, and a marked amplification of the structure, but also a profound change of type, in which, contrary to the transferent method, the Crustacean or inferior type takes into the cephalothorax *five* more of the body-segments than belong to this part in Insects; while, at the same time, the body is made normally larger by three segments. Moreover, in the highest Crustaceans, the Crabs, the head includes three more body-segments than in Insects. The differences also between Hymenopters and Dipters (see p. 17), Lepidopters and Homopters, Coleopters and Hemipters, exemplify a *general lowering of the grade of structure*, not referable to any special one or two of the methods of cephalization. The general term *potential* is applied to cases like the above on page 322 of Art. I, as a convenient term, though really applicable to all methods of cephalization.

Internal characteristics, as those of the digestive, reproductive

or nervous system, have not been referred to among the above characteristics, because (1) they often undergo very wide variations under a given type, and especially in its inferior or degradational subdivision; further, (2) when any internal condition is distinctive of a natural group of species, there is always some type or plan of general structure corresponding to it in limits; and (3) the type or plan of structure is the surest criterion as to whether a group is natural or not. As an example of this last, it may be observed that the *Radiate* or *phytoid* plan or type of structure overrides vast diversities, as to the nervous, digestive and reproductive systems; and so it is, though to a less degree, with subordinate types or plans of structure. Herbivores and Carnivores, regarding only the characteristic of food, blend as completely as any Lamarckian could desire; for there are omnivorous species of both tribes. And again, looking to the characteristics of the *placenta*, a point seemingly of great importance because connected with the process of development,—a *decidua* is developed, according to Huxley, in the *Herbivorous* Elephant and Hyrax, as well as in the Carnivores and higher Mammals, Bats, Insectivores and Rodents, but not in the Horse, Hogs, or Ruminants. And still Carnivores and Herbivores are in structure distinct natural groups. Besides other decisive distinctions, the former have without exception prehensile fore-feet, while in the latter, these organs are defünctionated of this power of prehension, and are simply locomotive organs.

Classification of Insects.

The three grander subdivisions of Insects have been indicated in Article I, on page 344—namely (1) *Prosthenics* or *Ctenopters*, (2) *Metasthenics* or *Elytropters*, (3) *Thysanures* or *Apters*.

The transition from the Prosthenics to the Metasthenics has been shown to depend on a transfer of force and function away from the systemic centre; and this by an abrupt transition, producing an abrupt downward step in grade.

This *retroferent* transfer is exhibited prominently in the wings, the *anterior* wings in the Metasthenics having little or no use in flying. These organs have been stated to have eminent importance in the order of Insects because the type is *aërial.* There is additional reason for this importance in the fact that the *dorsal* side of an animal is the *superior*, and the *ventral*, the *inferior ;* or, the former is the more *central* in the life-system, and the latter the more *circumferential.*

As the series of legs, as well as wings, may present cases of transfer of locomotive functions, the terms *Prosthenics* and *Metasthenics* become more precise if reference to the wings is included. They will thus be (πτερον being the Greek for wing) (1) *Pteroprosthenics*, and (2) *Ptero-metasthenics.* The two-winged species

under the former (the Dipters) have the *posterior* wings obsolescent, and those under the latter (Strepsipters) the *anterior*.[1]

Insects of the first of these grand divisions are eminently *pterosthenic* or *strong in the wing*—Hymenopters, Dipters, Lepidopters and Neuropters being relatively good flyers. Those of the second are as decidedly *podosthenic*—Coleopters, Hemipters and Orthopters being relatively poor flyers, and strong in the leg. Consequently the terms *Pterosthenics* and *Podosthenics* might be employed for the two grander divisions of Insects, as well as for those of Birds (Art. I, p. 343). Yet their use in the two cases would be different; for in Birds the wings and legs are relatively *anterior* and *posterior* members, and not *dorsal* and *ventral* as in Insects. But since the dorsal and ventral parts have a similar opposite relation to the systemic centre as the anterior and posterior, as just now remarked, the difference is one of degree rather than of kind.

As there are *pteroprosthenic* and *pterometasthenic* Insects, so there are *podo*prosthenic, or those in which the *anterior* legs are stronger than the posterior, and *podo*metasthenic, or those in which the *posterior* are the main organs of locomotion. Fleas and Grasshoppers, as they use their hind-legs for leaping, are examples of the latter. This sthenic difference in the feet, though of less weight as a mark of grade than that in the wings, is of real value among inferior subdivisions.

The *Thysanures* or *Apters*, which constitute the third grand division, are *urosthenic*, most of the species having even the power of leaping by means of the caudal extremity.

After these observations on the grander subdivisions of Insects, I present a synopsis of the general system of classification arrived at by the aid of the principles explained; and following this, some of the characteristics of the groups, especially those which are marks of grade on the basis of these principles. To the names in the synopsis are added only the two characteristics of (1) *perterrestrial* (terrestrial in both larval and adult life) or *semiaquatic* (aquatic in larval life), and (2) *permaturative* or *prematurative.*

I. Ptero-prosthenics, or Ctenopters.

1. APIPENS (from *Apis bee* and *penna wing*, the wings being approximately like those of the Bee).

a. Hymenopters.—Perterrestrial. Permaturative.
b. Dipters.—Mostly perterrestrial. Permaturative.
c. Aphanipters (Fleas).—Perterrestrial. Permaturative.

[1] As the anterior pair (or that which is obsolescent in the Strepsipters) is of little functional value in the Pterometasthenics, the distinction of two-winged or four-winged among them is of much less importance than among the Pteroprosthenics. Moreover, there is a line of gradation from ordinary Coleopters to the Strepsipters through the Rhipiphoridæ.

2. AMPLIPENS (from *amplus* large and *penna*).
   a. *Lepidopters.*—Perterrestrial. Permaturative.
   b. *Homopters.*—Perterrestrial. Prematurative.
   c. *Trichopters.*—Semiaquatic. Permaturative.
3. ATTENUATES, or NEUROPTERS.
   a. *Apipenniforms.*—Perterrestrial. Permaturative, or prematurative.
   b. *Amplipenniforms.*—Perterrestrial, or semiaquatic. Permaturative, or prematurative.
   c. *Perattenuates*, or *Typical Neuropters.*—Semiaquatic. Prematurative.

II. Ptero-metasthenics, or Elytropters.

a. *Coleopters.*—Mostly terrestrial. Permaturative.
b. *Hemipters.*—Mostly terrestrial. Prematurative.
c. *Orthopters.*—Terrestrial. Prematurative.
   α. *Cursors.*
   β. *Ambulators.*
   γ. *Saltators*, or *Typical Orthopters.*

III. Thysanures, or Apters.

Lepismians and *Podurians.*

I. PTERO-PROSTHENICS, OR CTENOPTERS.

1. Apipens.—The structures among Apipens are compact, comparatively uniform in proportions, and with rather narrow limits as to size, much narrower than in the Amplipens, Coleopters or Orthopters. The species are strongly pteroprosthenic, the anterior wings being much the larger. The wings are essentially of one type of form and texture, and are well described by the term *apiform;* they are free from scales and other defunctionating appendages or impediments, and are rapid in motion; in the second subdivision the posterior pair is wanting, and in the third, both pairs. The species are almost all perterrestrial. All are permaturative, and, with a few exceptions, they are so in the highest degree (Char. VI, A, *a*, p. 12).

a. Hymenopters.—The Hymenopters are the most uniform in shape or size of Apipens. The integuments are firm, the parts neatly adjusted and all well-proportioned. Among them, there are no imitations of the forms in other tribes, while they are extensively copied after—a characteristic peculiar to a type of the very highest grade.[1] The mouth has a suctorial lip for feeding;

[1] This point is well presented in a recent paper on "*Synthetic Types in Insects,*" by A. S. Packard, Jr., (*Jour. Boston, Soc. Nat. Hist.*, 1863, pp. 590–603). The author observes, on page 591, "the clear-winged *Sesia* [Lepidopter] imitates the humble-bee in its form and flight; the different species of Ægerians [Lepidopters] simulate members of nearly every hymenopterous family, as we can see when recalling such names as *apiformis, vespiformis, philanthiformis, tiphiæformis, scoliæformis, spheciformis, chrysidiformis, cynipidiformis, formiciformis, ichneumoniformis, uroceriformis*, and *tenthrediformis*. So also other Ægerians resemble different family forms of Diptera, as seen in the names of *culiciformis, tipuliformis, bibio-*

but, besides this, well-developed mandibles, and these serve in many species for the high purposes of making nests, taking prey, transporting young and food: the jaws are therefore *perfunctionate* in these species to a degree comparable with that of the jaws of a Carnivore among Mammals. The higher kinds also supply the young with food, either by storing it or by direct feeding—a quality approximating to that of the Altrices (Nursers) or highest subdvision of Birds. The food is either vegetable or articulate-animal, not vertebrate-animal; the animal food being thus the same in kind with the material to be made of it, just as, among *Mammals*, the highest of Carnivorous species live on the flesh of Mammals, and only the lower on fish and insects. Individuals of many of the higher species live in communities for mutual work and with sometimes a special division of the work among them. The wings are fitted eminently for the legitimate purpose of flying, and are typical in size, texture and power. The species are all perterrestrial.[4]

The above characteristics show that the tribe of Hymenopters takes the lead among Insects, and therefore stands at the head in the subkingdom of Articulates.

Note on Size under the Insect-type.—If, then, Hymenopters stand *first* among Insects, we may learn from the higher of the species the *normal size* of the Insect-type under its best condition as to structure, form and functions. This *archetypic* size is between 8 and 12 lines (or twelfths of an inch) in length and 2½ and 3 in breadth:—taking the Wasps as the superior type, 11 lines by 2½ to 3; taking the Hive-bee, 8 by 2½. Such being the size connected with the most highly cephalized condition of Insect-life, (1) any larger size of structure among inferior tribes of Insects is an exhibition of *amplification*, that is, of a more diffused condition of the systemic force—which force never exceeds that of the archetype, and may be less to any degree; (2) the more inferior the group in which large forms occur, the greater the amount of

formis, *anthraciformis*, *muscæformis*, &c. In the Diptera we find *Bombylius*, resembling, as its name implies, *Bombus*; and also *Laphria*, which so closely apes the humble-bee in its form, coloration, size and flight, even to the buzz, which is, if anything, still louder. Also there is the strongest resemblance in some *Syrphi* to *Vespa*, and especially to different species of *Crabro*. But while the Lepidoptera and Diptera resemble the Hymenoptera, we cannot say that Hymenoptera ever *assume* the form of any flies and moths. They seem isolated; and resemble only themselves. In the case of the *Laphria*, the plump, bee-like form, and the dense yellow and black hirsuties, which cause them to be mistaken for humble-bees by persons unacquainted with their structural differences, are just those features that are exceptional in the Diptera, and are normal in the Hymenoptera. The fly to get them has to pass over one sub-order to obtain a bizarre form which is a prevalent and common family attribute of the Apidæ."

Addition to Note, while in the press.—These, and other observations beyond, for which I am indebted to Mr. Packard, are so apposite to my subject as to appear as if prepared for the use here made of them. In fact, however, my paper with its notes was written without any acquaintance with the author beyond what I had derived from his valuable paper, and also without his knowledge.

[4] Some Hymenopters can swim with their wings or legs; but none are semiaquatic.

amplification for any given size; and (3) structures below the archetypic size in inferior groups may be amplificate upon smaller life-systems. Thus the gigantic size of some beetles is *evidence* of their inferiority to the Hymenopters, however it may be among Coleopters themselves; the great size of some Longicorn Coleopters is unquestionably a mark of inferiority among Coleopters, as they belong to an inferior subdivision of the tribe of Coleopters; the extravagant size of some Orthopters is a mark of much lower inferiority, as this type is one of the lowest in rank; and the moderate size among Hemipters, which does not exceed the mean size of Coleopters, is amplificate, since the Hemipter-type is much inferior to the Coleopter-type.

b. Dipters.—The Dipters vary widely as to general form of body, and considerably in size, though never attaining the magnitude of some Coleopters; but in their wings and legs there is a general uniformity. The integuments are less firm than in Hymenopters. The mouth is simply suctorial, and self-feeding is the only function. Individuals never live in communities. The food is various, either vegetable, articulate-animal, or vertebrate-animal, and either living, freshly dead, or decaying. The species are mostly perterrestrial,—one group among the attenuate, and therefore inferior, kinds being semiaquatic.

The rudimentary condition of the posterior wings in Dipters is attended with (1) an enlargement of the mesothorax (the segment supporting the anterior pair) at the expense of the metathorax (or posterior segment of the thorax), and (2) an increased size in the wings, making their surface nearly equal to that of both pairs in Hymenopters. It is hence an example of *forward transfer* of function, such as attends higher cephalization, and not of ellipsis through degradation. But while this characteristic proves cephalic concentration, others of this type show that the *degree* of force thus concentrated is far less than that of the Hymenopter-type. For the Dipters evince in all points their inferiority:—for example, in the structure or functions of the mouth, in their vastly wider limits of variation as to shape and size, in their many imitations of Hymenopters, in the semiaquatic life of some species, their less strength as compared with size, their habits, &c. It is stated on page 12 that the transition from Hymenopters to Dipters is an example of a *general lowering of grade* not referable to the particular methods of cephalization enumerated; that is, it is a case of profound *potential* difference registered in the general structure rather than in any one structural characteristic.

The foot note on the preceding page states some of the relations between Dipters and Hymenopters. On this point Westwood says: "It seems to be admitted on all hands that the Insects which are the real analogues of the Hymenopters exist in

the Dipterous order, almost every Hymenopterous genus having its representative in the latter." The analogies as well as affinities are so many and close that there can be no question as to the union of the Hymenopters and Dipters in the one group of Apipens.

c. Aphanipters.—Fleas have a suctorial or haustellate mouth like Dipters, and firm shining integuments like Hymenopters; and, as with the higher species of both tribes, they are permaturative in the highest degree, and perterrestrial. But while thus related to the Hymenopters and Dipters, they differ from both, not only in the less important fact of having no wings, but in being metapodosthenic, for the hind-legs are not merely the longest pair, but the main reliance in leaping. They show that they are an independent type, also, in the structure of the haustellate mouth, which is different from that of the Dipters; and also in their strength and agility. Defrance asserts that the female places with the eggs some bits of dried blood; and if so, there is a degree of nursing among Fleas which is an additional relation to the Hymenopters. The body is amplificate behind. The absence of wings is to be attributed to ellipsis through decephalization.

2. **Amplipens.**—The Amplipens are amplificate species, being eminently broad- or long-amplificate in their wings, and usually either long- or gross-amplificate, or both, in body; and among them there is a very wide diversity in shape and size, in which respect they are quite in contrast with the Hymenopters. The wings in the more typical species are slow in motion and are covered with scales and variously colored, often seeming like a wide spread of canvas for the display of pretty colors. The mouth in the adult is rostrate (except in a hypotypic group of species that eat nothing in the adult state) and has no function besides that of feeding. The species are all perterrestrial, except in the hypotypic group referred to. Those of the highest subdivision are permaturative, and the rest are prematurative; and when permaturative they are so only in the second degree (Char. VI, A. *b*.), the larves being very active, and furnished with strong jaws and feet.

a. Lepidopters.—The wings of Lepidopters are typically very broad-amplificate, scale-covered and variously colored, with the anterior pair the larger; in inferior species the wings are comparatively narrow, but through degradation of type. The amplificate character of the tribe is also apparent in the fact that the *smallest* species are far larger than the smallest of Apipens and of most other tribes of Insects. The mouth is haustellate, with the mandibles atrophied or nearly so.[5] The species are all

[5] It has been argued that since the larves of Lepidopters have mandibles, while the butterflies have these organs only in a rudimentary state, the latter condi-

perterrestrial and permaturative. Some caterpillars are in a sense social, but not for mutual work, and adults are never social.

b. Homopters.—In Homopters, the wings, though large, are less broad than in the typical Lepidopters. They are submembranous or a little thickened in the larger species, but not scale-covered, and are thin-membranous in the smaller; they are sometimes colored (in *Fulgora*, *Cercopis*, &c.), as in Lepidopters; the posterior are often equal to the anterior, and sometimes larger; in many species they are deflexed in position, roof-like. The mouth is simply haustellate and suctorial; though having mandibles, they are enclosed within the rostrum. The species are perterrestrial, as in the preceding group, but are prematurative.

Prof. Agassiz, in his memoir on the Classification of Insects, (see note below,) places the Hemipters (including under this term the Homopters as well as Hemipters) next to the Lepidopters, on the ground of the structure of the mouth and their development. While this cannot be sustained with regard to the proper Hemipters since these are *pterometasthenic*, it is true of the Homopters which have sometimes a striking resemblance to Butterflies in their large-amplificate, colored wings, besides being *pteroprosthenic* and otherwise approaching the Lepidopters.

c. Trichopters.—The Trichopters, while permaturative like the Lepidopters, are *semiaquatic*, and hence are inferior to both Lepidopters and Homopters. The wings are pilose, and are veined like those of a Lepidopter instead of being reticulate like those of a Neuropter; in position they are deflexed, roof-like, as in many Homopters and Lepidopters. The mouth-organs are almost completely atrophied, and the adult takes no food, so that the Phryganea has little use for its head, being almost solely a procreator. The larve spins silk-like fibres from

tion is evidence of superiority of rank *among Insects in general.* (See Agassiz on the Classification of Insects from Embryological data.) But as Lepidopters are on various grounds inferior to Hymenopters, this is manifestly one of the many cases in which the embryological law with regard to grade does not hold good. Others are alluded to in the remarks on the *elliptic* method of decephalization, on page 440 of the last volume of this Journal. An additional example is afforded by the Cirripeds. The *attached* amplificate and defunctionate Barnacle or Anatifa is not superior to the free Cypris or Ostracoid Crustacean, although it is the *adult* stage following an earlier Cypris-like condition of the animal. So in the case of any *attached* species, the moment of becoming attached is the commencement of vegetative increase, partial or complete defunctionation of the organs of sense, and general decline in grade. The progress thence is backward, toward a plant-like condition; it is a degradation of the type, as much as when the digestive system of certain Nematoid Worms becomes atrophied with growth.

Exceptions like these do not set aside the embryogenic law of grade: they only show that this law must sometimes, at least, be tested by the profounder law of cephalization, before it can be safely followed in determining the grade of species. For, as the writer has observed elsewhere (*this Jour.*, [2], xxv, 213, 1858), the steps in embryogenic development are, in a general way, steps in the cephalization of individual growth. The former affords aid toward understanding the latter; and the latter principle, once recognized, more than reciprocates.

the extremity of the abdomen, or the lip, or both, and by this means unites bits of sticks, pebbles, etc., into a portable case or sheath for itself.

All entomological writers acknowledge that the Trichopters resemble Lepidopters. They have so much the aspect of some Phalænids, that they were called *Mouches papillonacées* by Reaumur; and the larves, according to De Geer, are closely like caterpillars in internal organization. Other Lepidopteroid characteristics mentioned by different authors are observed in the rudimentary condition of the mandibles, the structure of the legs, the faculty of spinning fibres possessed by the larve, the portable larval sheath closely imitating those of the larves of many Tineids and the Psychids. One genus of Phryganeans is named Hydropsyche in allusion to the resemblance, and Newman transferred the genus Psyche from the Lepidopters to the Trichopters. The species naturally constitute a hypotypic group to the Amplipens. The hypotypic division of a terrestrial group often consists of aquatic or semiaquatic species. Although the Trichopters are generally united to the Neuropters, they are always placed to one side in a group by themselves, on account of their wide divergence from that type. The parallelism between the subdivisions of Amplipens and those of the Amplipenniforms on page 22, further sustains our arrangement.

3. Attenuates, or Neuropters.—The Neuropters are mostly long-amplificate, being generally slender in body, wings and legs; they are also widely diverse in shape and size. The wings are membranous, but are sometimes partly colored; they are often equal; the posterior are sometimes even the larger, but sometimes also much the smaller, and occasionally obsolete. In a few species both pairs are wanting. The mouth, unlike that of the Lepidopters and Homopters, but like that of most of their *larves*, is not suctorial but mandibulate. Among the species there are perterrestrial and semiaquatic kinds, and also permaturative and prematurative.

Two of the subdivisions of Neuropters appear to be representatives severally of those of Apipens and Amplipens, and may accordingly be named the *Apipenniforms* and *Amplipenniforms*. The third includes the *typical* Neuropters, the species which stand most widely apart from the other tribes of Insects.

a. Apipenniforms.—The Apipenniforms show their relation to the Apipens, both in their structure and habits, the higher species being related to the Hymenopters, through the Ants, and the lower to Dipters, through the Tipulids. Like Apipens, also they are all perterrestrial, although not all permaturative. The two subdivisions are (1) the *Termitideans* (White-Ant group) or Hymenopteroid species whose Ant-like habits are well-known; and (2) the *Panorpideans* or Dipteroid species, having the mouth

rostrate, the wings narrow, and the legs and body slender, as in the Tipulæ.[6]

b. Amplipenniforms.—The Amplipenniform Neuropters are related to the Amplipens in having the wings amplificate; but, as follows naturally from the fact of the inferior grade of Neuropters, these wings resemble rather the narrower forms of the inferior Lepidopters, or those of the Homopters and Trichopters, than the wide forms of the typical species—they being long-amplificate and at the same time only sparingly broad-amplificate. In some species they are partly colored, another Lepidopteroid character. They diverge most widely from those of the Lepidoptera in being reticulate, which is a special *Neuropterous* characteristic, although not without exceptions. The posterior pair is sometimes a little broader than the anterior. The species are either perterrestrial or semiaquatic, and either permaturative or prematurative.

[6] A. S. Packard, Jr., in his memoir already mentioned remarks as follows on the Termites, and the Panorpids.

"The *Formicidæ* among Hymenoptera have in the Neuroptera their well-known analogues, the *Termites* or White Ants. Like the true ants, these interesting insects rear nests of sand or clay, or the colonies are concealed beneath various objects, or in decayed trees and roots. There are also a differentiation of the individual, a partition of labor, and wonderful instincts, as in ants. Those characters which place the *Termitidæ* the highest in their suborder are just those which make them so much like Hymenoptera. Thus, in the small occiput, the large epicranium which occupies the largest part of the head, and in the general arrangement of the small mouth-parts, this family differs widely from other Neuroptera. Though the prothorax is large, yet the middle region of the body is massed together more than usual. Like the ants, the costal nervures of the wings are well-developed, while those occupying the hinder portions of the wings are obsolete. Indeed, both the true and white ants do not fly much, and that for the most part when swarming."—p. 601.

"The family *Panorpidæ* assumes dipterous shapes. *Bittacus* has its analogue in the fly *Bittacomorpha*. The resemblance of the female *Panorpa* to *Tipula* is very striking. In both the mouth parts are greatly elongated, and the head much produced in that direction, leaving a very short vertex; and the antennæ are much the same in size and shape. Panorpa is remarkable for the short, ovate, compressed thorax, owing to the reduced size of the prothorax, and the compactly massed notal and side pieces, wherein it simulates Tipula; but the resemblance is still greater in the elongated episterna and coxæ, and the long slender legs. If we go more carefully into a comparison of the notum of both insects, we shall find the large mesoscutum, the short scutellum, and the longer-than-broad horse-shoe-shaped scutum of the metathorax of Panorpa closely resembling those pieces in Tipula. There is the same form of the first pair of wings. In both the straight costa bends gradually around at the apex, as the inner edge curves up just as rapidly to meet the costa at the apex which is situated in the middle line of the wing. Also in the disposition of the main nervures, their relative distances apart, and their termination, even to the formation of the pterostigma and the branches that lead to and from it, the analogy is still maintained. At the base of the wing, and towards the outer margin of Tipula, there are a few cross recurrent nervules, and irregularities in the branching of the principal nervures that remind us of the system of net-veins that cross the wings of Panorpa. The abdomen in the two genera is dilated at its base and appressed to the thorax; and in its long cylindrical form it bears a similar proportion to the head and thorax, while the swelled extremity and genital pieces in the females of both genera are strictly analogous. Both genera agree, according to the representations of authors, in supporting themselves on their long legs, while introducing their slender and pointed abdomen into the earth, when about to deposit their eggs."—pp. 594, 595.

They include: (1) the *Planipennians,* (Myrmeleontids, Hemerobiids, Nymphids, Mantispids and Semblids) which are Lepidopteroid in being *permaturative*, as well as in the other character already mentioned, and which, excepting the Semblids, are all *perterrestrial.*—(2) The *Psocideans*, which are Homopteroid in being *prematurative* and perterrestrial, and which, as observed by Packard, approach in form and in the roof-like position of the wings the Homopterous group of Aphides.[7] The little book-lice belong to this group, and thus represent the plant-lice among the Homopters.—(3) The *Perlideans*, semiaquatic and prematurative species, which are Trichopteroid (or like the Phryganeans) in the form of the wings, in the larve being not only aquatic but also *living in a sheath*, and in the adult eating little or nothing.

Thus each subdivision of the Amplipens, the Lepidopterous, Homopterous and Trichopterous, appears to be represented in the subdivisions of the Amplipenniforms.

The subdivisions of Attenuates or Neuropters deduced are the following:

1. APIPENNIFORMS.
    1. *Termitideans*, or Hymenopteroid group.
    2. *Panorpideans*, or Dipteroid group.
    3. *Aphanipteroid.* Group unknown.
2. AMPLIPENNIFORMS.
    1. *Plannipennians*, or Lepidopteroid group.
    2. *Psocideans*, or Homopteroid group.
    3. *Perlideans*, or Trichopteroid group.
3. PERATTENUATES OR TYPICAL NEUROPTERS.
    1. *Libellulideans.*
    2. *Ephemerideans.*

As the higher Apipenniforms, the *Termitideans*, are *prematurative*, while the Dipteroid *Panorpideans* and the higher Ampli-

[7] Mr. Packard observes with regard to the Psocideans:—

"The *Psocidæ* find their analogues in the Hemiptera [Homoptera]. The species of Psocus are so much like the Aphidæ that when flying they are often mistaken for each other. And, indeed, in the short broad body and broad head and long antennæ, in the very unequal wings, which are folded roof-like over the short abdomen, in their simple neuration, in the short legs and feeble tarsi, and in their mode of flight and their appearing winged towards the close of summer, these small insects are remarkably like the winged plant-lice."

He also illustrates at some length the relations of some of the Planipennians to the Lepidopters, in the course of which he remarks, that among the Myrmeleontids "*Ascalaphus* was described by Scopoli as a Papilio, and has been said by Kirby to resemble Heliconia." The form of the antennæ is strikingly Lepidopteroid in its club-like shape, and its rather broad wings are colored. We add that the species of *Drepanopteryx*, a genus of the Hemerobiids, closely resembles some of the small Butterflies, and is called *D. phalænoides*.

penniforms or Plannipennians are *permaturative*, it might be questioned whether the latter groups should not rank before the Termitideans, among Neuropters. If so, then the groups considered as Dipteroid and Lepidopteroid would stand above the Hymenopteroid. But since Hymenopters are the highest of Apipens (and the highest therefore of Insects), and consequently occupy a level far above that of the Dipters (the second subdivision of Apipens), or that of the Lepidopters (the first of Amplipens), it is natural that the descent required to bring the Hymenopterous type down to a Neuropterous level should be much the greatest; and hence comes apparently this sinking to the *prematurative* characteristic,—the *Hymenopteroid* division *prematurative*, being not below the Dipteroid or Lepidopteroid *permaturative.*

c. Perattenuates or *Typical Attenuates.*—The body and wings in these species are narrow or long-amplificate, the posterior wings sometimes small or wanting. The species are *semiaquatic* and *prematurative.*

They include: (1) the *Libellulideans*, which have the wings nearly equal, and the mandibles stout; and (2) the *Ephemerideans*, which have the posterior wings smallest and sometimes obsolete, and the mouth organs in the adult atrophied. The latter show their inferiority in being short-lived and in eating nothing or but little in the adult state; the functions of the adult are almost solely those of the *posterior* portion of the body.

II. PTERO-METASTHENICS, OR ELYTROPTERS.

a. Coleopters.—Coleopters, in their compact structures consisting of well-adjusted parts, their comparatively limited diversity of form, and their being imitated by many species of other tribes while never themselves imitators,[8] exhibit the characteristics of a type of the highest grade in its subdivision. At the same time they show inferiority to the Hymenopters in their

[8] A. S. Packard brings out this fact, in his pamphlet, in connection with the corresponding one with regard to Hymenopters already cited. He says "There is a similar parallelism of analogous forms between the Coleoptera, Hemiptera, Orthoptera and Neuroptera, which seem bound together by affinities such as those that unite by themselves the Bees, Moths, and Flies." "The suborders below reach up and connect themselves by these remarkable analogies with the Coleoptera, which do not in turn assume any of their forms. Some Orthoptera are very Coleopterous-like, and some Hemiptera are very Coleopterous-like. The reverse cannot be said."

Mr. Packard, adopting, yet it would seem from his words provisionally, the two grand divisions of Insects of *Mandibulates* and *Haustellates*, remarks that they *culminate* in the Coleopters and Hymenopters, respectively. As the Hemipters are *haustellate*, the facts respecting their relations above mentioned go against this old division of Insects and sustain fully the new arrangement proposed in which the Hemipters follow the Coleopters although the latter are mandibulate,—the distinction of mandibulate and haustellate, as the system shows, being one of minor importance.

stouter or grosser forms, and their greater diversity as to size and shape; in the jaws of the highest species being perfunctionate to a less degree; and, very decidedly in their metasthenic nature as regards the wings, the anterior pair being only wing-covers or elytra. The mouth is mandibulate, and often rodent as well as feeding. In some species there is a degree of care for the young that approaches somewhat that in the Hymenopters. They never live in communities for mutual work. The food, like that of Dipters, is various, being either vegetable, articulate-animal or vertebrate-animal, the last either living, freshly dead or decaying. The species are mostly perterrestrial. They are all permaturative.

b. Hemipters.—Among Hemipters the structures are rather laxly put together compared with those of Coleopters, the body thinner and softer, the wings usually more or less overlapping; and their strength for the same size very much less. There are some of the same differences between Hemipters and Coleopters as between Dipters and Hymenopters. Though never very large, they appear to be amplificate species,—sometimes broad-amplificate, being thin for their breadth, and sometimes long-amplificate. The elytra are coriaceous only in the basal half; and this thinning of the wing-covers comports with their being systemically weaker animals than Coleopters. All the wings are sometimes obsolete, as in the Pediculi. The mouth is suctorial, and simply gnawing and feeding in function. The species are mostly perterrestrial, and all are prematurative.

c. Orthopters.—The Orthopters also have a lax structure and rather soft bodies. They are either broad- or long-amplificate, and sometimes extravagantly so, and by their occasional great size, as well as the non-occurrence of very small species, they exhibit the low inferiority of unconcentration: they are low *because* large. The elytra are semicoriaceous. Both pairs of wings are sometimes obsolete. The mouth is mandibulate, and simply gnawing and feeding in function. The species are mostly perterrestrial, never semiaquatic; all are prematurative.

The Orthopters include three grand subdivisions,—the *first* and *second* representatives respectively of Coleopters and Hemipters, and the *third* typical.

(1) The *Cursors* or *Coleopteroid* species consist of the Blatta and Forficula groups, which, though elongate, are still comparatively short in body, and much like Coleopters; the wings in the Blattids are rather lax, and the bodies soft for the size.

(2) The *Ambulators* or *Hemipteroid* species, that is, the Mantids and Phasmids. The species are often thin and broad, and simulate leaves, bark and sticks in color and markings; and in this respect this group and the Hemipters show an approximation. There is also some approach between these groups in the

texture of the wings as well as the rather slow habit of body in many kinds. The Orthopterous Nirmids or Bird-lice represent the Hemipterous Pediculi or common lice, and so nearly that they are often arranged together in one tribe. The resemblance of these Orthopters to the Hemipters is less close than that of the preceding subdivision to the Coleopters. It is to be considered, however, that the Hemipters, although amplificate, are much more restricted in size, and therefore do not run off into those extravagances which give to Orthopters their most obvious features.

(*c*) The *Saltators*, or *Typical* Orthopters, (Grasshoppers, Crickets, &c.,) differ from the preceding in being strongly *podometasthenic*, a mark of low inferiority. The species show that they are the typical Orthopters by their trim and well-made forms, their great leaping powers, and the absence of any close likeness to other groups.

III. THYSANURES, or APTERS.

The Lepismians and Podurians are the only apterous Insects here included.

The *Lepismians* are larve-shaped with the distinctions of head, thorax and abdomen imperfect; the abdomen is long and 9 or 10 jointed; the body is usually covered with scales as in Lepidopters: the extremity of the abdomen bears setæ as in some Neuropters and Orthopters. The mouth is mandibulate. They are quick in movement, having a worm-like motion, and some of them leap by means of the caudal extremity.

The *Podurians* are rather short in body, the abdomen short, 4 to 6 jointed; the body sometimes scaly; the extremity, or the under surface near the extremity, furnished with a seta for leaping except in one genus *Anura;* the mouth mandibulate except in the Anuræ, in which it is suctorial.

The Lepismians have been often said to be related to both Lepidopters and Neuropters, and some authors regard them as apterous species of the latter group. Erichson referred them to the Orthopters.

The reasons for making the Thysanures a third grand division of Insects, and for not including in the same other apterous groups, are as follow:

1. The agility of movement of these species show that they are not degraded forms pertaining to the inferior limits of another higher type, but constitute an independent type, or, are typical in the grand division to which they belong.

2. While the Lepismians may be regarded as related to Lepidopters and Neuropters, such caudal setæ are found in no Lepidopter and the scales on no Neuropter. They stand in distant relation to both.

3. The forms among the Lepismians are related to those of Myriapods, as has been observed by different writers, and so also are their movements. Thus they occupy a position between Insects and an inferior order of Insecteans.

4. The third or degradational group of Insects, if such there be, should contain, according to analogy, elongated larve-like forms, such as make an elementalized exhibition of the Insect-type. As the longicaudate Birds, or Erpetoids, constitute the third or degradational division of Birds (aërial Vertebrates), so the longicaudate Thysanures may well represent the degradational division of Insects (aërial Articulates). The shorter Podurians are elliptic forms.

5. While Insects of the *first* grand division are *prosthenic*, and those of the *second* are *metasthenic*, those of the *third* are, on the scheme proposed, *urosthenic*, even those few which are not saltatorial using the caudal extremity in locomotion. It accords with the relations in many other departments of the animal kingdom that these three sthenic grades should mark off the three grand divisions.

6. With regard to the exclusion of other apterous Insects, we offer the following remarks. The apterous Pediculi, as Nitzsch long since observed, have no characteristics that would separate them from Hemipters, and the Nirmids none that would remove them from Orthopters. They are simply inferior wingless species of those types, as much as the Coccids are of Homopters; and they have nothing of the agility of the Lepismids. There are no points of structure indicating an affinity to any two or more of the higher subdivisions of Insects, or to the inferior Myriapods; they are not *urosthenic*, being in no way essentially different, as regards their legs, from the types to which they are referred.

Fleas are permaturative, like all Apipens, and in this and other ways show that they have no relations to the Lepismians. The reasons for regarding them as an independent type under the Apipens have been presented on page 18.

The Lepismians and Podurians appear therefore to be rightly made the *third* grand group of Insects. Like the Erpetoid birds, and degradational or intermediate types in other cases, the group may have been well-represented in species in past geological ages. At the present time we know of only the two above-mentioned families under this type, and both are supposed to have closer relations to the Pteroprosthenics than to the Pterometasthenics. If any group ever existed related as closely to the Pterometasthenics, as the above mentioned are to the Pteroprosthenics, and if, besides, there has existed a third *typical* group, the species are yet to be discovered, either fossil or living.

Parallelism between Pteroprosthenics and Pterometasthenics.

(1.) *Between the subdivisions of the Pterometasthenics and those of Apipens, or the higher Pteroprosthenics.*—The two *first* subdivisions, *Coleopters* and *Hymenopters*, are much alike in having compact well-made forms and comparatively small limits of variation, and freedom from imitation of other species while imitated by many—characteristics which belong to the highest typical subdivision of a group. They are approximately alike in having the mouth mandibulate, although unlike in that the latter (or highest species) are also suctorial; alike also in being with few exceptions terrestrial, and also in being permaturative.

Hemipters and Dipters, or the two *second* subdivisions, are alike in having the mouth suctorial, and feeble species for their size as compared with those of the first subdivisions.

The *typical Orthopters* and the *Aphanipters*, or the types under the two *third* subdivisions, consist alike of saltatorial and *podometasthenic* species.

(2.) *Between the three subdivisions of the Pterometasthenics and the three of the Pteroprosthenics.*—The more prominent of the relations between *Coleopters* and *Apipens* have just been mentioned. Those of *Hemipters* and *Amplipens* are still closer; Hemipters being so near to Homopters in structure, and especially in the composition of the rostrate mouth, that they have been placed together in the same tribe by most entomologists.

The *Orthopters* and *Neuropters*, or the *third* subdivisions of each, show a degree of approximation in the close resemblance in form between the Neuropterous Mantispids and the Orthopterous Mantids, indicating a tendency to run off into the same style of amplificate structure, and also in the Cricket-like form of the Neuropterous Borei; more profoundly in the resemblance in structure of mouth and the nature of the metamorphosis between the Neuropterous Perlæ and the Orthopterous Phasmids, as remarked upon by Westwood.

Thus the grand divisions of the Pterometasthenics constitute a parallel series to those of the Pteroprosthenics.

The further parallelisms, under both the Pteroprosthenics and Pterometasthenics, between the *third* of the grand divisions of each and the *first* and *second* have been explained on pages 20 to 22, and 24.

The affinities and analogies of species and groups appear hence to be fully exhibited in the system of classification presented, far more so than in any arrangement of osculant circles.

(3.) *Between the several groups as to the number of subdivisions, and the grades of types constituting them.*—The number of subdivisions in the groups, both the higher and lower, is *three*, as in most of the classes and orders that came under consideration in *Article I.*

Of these three subdivisions both among the Pteroprosthenics and Pterometasthenics—the first and second grand divisions of Insects—the *two* higher are *typical*, of different grades, and the *third* is *hypotypic*. The same is true of the three subdivisions of each the Apipens and Amplipens, or the first and second grand divisions of the Pteroprosthenics. This is exhibited in the following table, in which the grades are expressed by the same terms as in Article I.

	Pteroprosthenics.	Pterometasthenics.	Apipens.	Amplipens.
Betatypic,	Apipens.	Coleopters.	Hymenopters.	Lepidopters.
Gammatypic,	Amplipens.	Hemipters.	Dipters.	Homopters.
Hypotypic,	Attenuates.	Orthopters.	Aphanipters.	Trichopters.

In the *third* or *hypotypic* division of both the Pteroprosthenics and Pterometasthenics, on the contrary, the first and second of the three subdivisions appear to be *hypertypic* groups, while the *third* is *typical;* and the hypertypic groups are more or less closely representatives respectively of the first and second grand divisions, as follows:

	Attenuates, or Neuropters.	Orthopters.
A-Hypertypic,	Apipenniforms.	Coleopteroids, or Cursors.
B-Hypertypic,	Amplipenniforms.	Hemipteroids, or Ambulators.
Typical,	Perattenuates.	Saltators.

In the fact that these hypotypic divisions include *two hypertypic* subdivsions and *one*, the inferior, *typical*, there is a parallelism with the subdivisions of Fishes, (Art. I, p. 343,) and those of many other hypotypic groups of animals.

Methods of cephalization, or decephalization, at the basis of the successive grades of subdivisions.

A. In the subkingdom of Articulates, as shown by the writer (last volume, p. 7) and long held by Agassiz, the classes or highest subdivisions are *Insecteans*, *Crustaceans*, and *Worms*.

In passing from *Insecteans* to *Crustaceans*, the principal methods of decephalization illustrated are the *amplificative*, there being a great enlargement through apocentric or circumferential extension; the *dilutive*, or a change from perterrestrial to aquatic life and respiration (See Char. V, p. 12,); and, over and above these, a fundamental change of type not expressed in any of the special methods of decephalization laid down, (page 12).

In passing from *Crustaceans* to *Worms*, the methods illustrated are the *analytic*, in the resolution of the body mostly into its normal annuli; the *multiplicative*, in the indefinite number of segments; the *elliptic*, in the absence of antennæ, feet, &c.

B. The grand subdivisions of Insecteans are *Insects*, *Spiders*, and *Myriapods*.

In passing from *Insects* to *Spiders*, the methods of decephalization illustrated are the *retroferent*, case *a*, in the transfer of one pair of mouth organs to the locomotive series; and a shade of the *analytic*, in the loss of the independent definition of the head and thorax.

In passing from *Spiders* to *Myriapods*, the methods illustrated are the *analytic*, in the loss of independent definition of thorax and abdomen, and the reduction of the body to nearly equal rings all with nearly similar members; and the *multiplicative*.

C. The grand subdivisions of Insects are *Pteroprosthenics*, *Pterometasthenics*, and *Thysanures* or *Apters*.

In passing from the first to the second, the principal method illustrated is the *retroferent*, case *b*, as shown in the transfer backward of the flying function, and also in the locomotive function being transferred in a considerable degree from the wings to the feet.

In passing from the *second* to the *third*, the methods exemplified are the *analytic*, shown in the equal annuli and partial loss of distinction of thorax and abdomen; the *retroferent*, case *b*, in the transfer backward to the caudal extremity of a part of the locomotive function; *elliptic*, in the absence of wings; *prematurative*, in there being no metamorphosis.

D. The grand subdivisions of the Pteroprosthenics are the *Apipens*, *Amplipens*, and *Neuropters* or *Attenuates*.

In passing from the *first* to the *second*, the principal method illustrated is the *amplificate*, especially the broad-amplificate, as exhibited largely in the wings. In passing from the *first* and *second* to the *third*, the *amplificate*, especially the long-amplificate, accompanied by a general diminution and inferiority of life-system, the species being mostly rather small and slender.

The methods are in general the same for the subdivisions of the *Pterometasthenics*.

E. The grand subdivisions of the Apipens are the *Hymenopters*, *Dipters* and *Aphanipters*.

In passing from the *first* to the *second*, there is a ***general lowering of grade of structure*** (p. 12,) as exhibited in inferior integuments and strength, and partly defunctionated mouth.

In passing from the *second* to the *third*, the methods exemplified are the *elliptic*, in loss of wings; the *retroferent*, in the locomotive function being transferred largely to the hind-legs, these being the strongest and longest; the *amplificate*, in enlargement behind and in length of legs.

F. The grand divisions of the Amplipens are *Lepidopters*, *Homopters* and *Trichopters*.

In passing from the *first* to the *second*, the methods exemplified

are mainly the same as in passing from the first to the second under the Apipens. In passing to the *third*, there are the *semi-dilutive*, the larves being aquatic; and the *defunctionative*, the mouth in the adult failing mostly of the organs and function of feeding.

The same *potential* method, which distinguishes *Hymenopters* from *Dipters*, or the two highest subdivisions of Apipens, also distinguishes the two highest of Amplipens, or *Lepidopters* and *Homopters*, and the two highest of Pterometasthenics, or *Coleopters* and *Hemipters*.

It is not necessary to continue these illustrations further.

From the above review of the relations of the successive stages of groups, it is seen that the distinctions between them are throughout strictly *ordinal*, taking the word in its primary sense; that is, all, from the highest to the lowest, are distinctions *in rank*.

Two other points are to be observed in this connection.

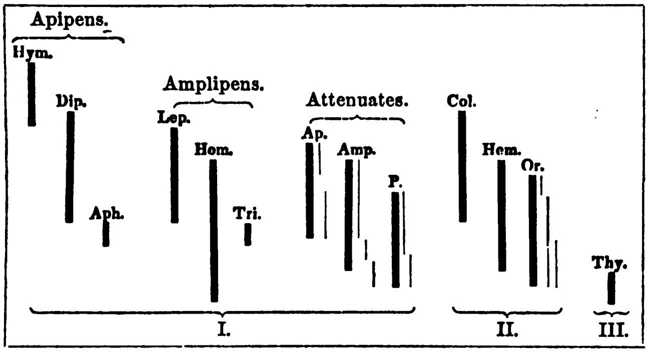
a. The lowest subdivisions of both the Pteroprosthenics and Pterometasthenics are long-amplificate; and in their subordinate subdivisions the same method is often illustrated.—Some Orthopters of the family of Phasmids have a length of a foot: there is here a diffusion of the systemic force through a radius *twelve times as great* as in a typical Hymenopter. Besides this, the force thus diffused is much less, for the tribe is among the lowest in the order of Insects. The *long-amplificate* method is frequently that of the inferior subdivision in groups of various grades.

b. The degradational species under a high type are often far inferior to the typical species of a very low type.—Thus species of Aphis and Coccus under the Homopters, the former leading almost a stationary life and reproducing by budding, the latter budding also and completely stationary as regards the female, are very inferior in the attributes of life to the active Lepismæ. As the author has illustrated in his paper on Crustaceans, a type of structure requires a certain amount of force to be worked to advantage; and if this force is diminished beyond the proper limit, the animal loses activity and becomes low and stupid in every function except often the vegetative of growth and reproduction. An active animal under this amount of force can be had only by a change of type to an inferior grade adapted to the force.

These two principles are of great importance in classification. The first affords an indication of inferiority not to be overlooked; the second accounts for the association in one group of very high and very low species.

The following diagram appears to the writer to represent approximately the relative grades of the ranges of species under the several subdivisions of Insects in the proposed classification. Along side of the vertical lines standing for the groups of Attenuates and Orthopters, there are other finer vertical lines for

ıeir subdivisions (pp. 22, 24). The line for the Homopters is ıade to run lowest on account of the Aphids and Coccids,



rhich seem to be inferior even to the Pediculi of the Hemipters nd Nirmids of the Orthopters.

Designations of the successive grades of groups.

The parallelism between the grander subdivisions of the 'terometasthenics (Coleopters, Hemipters and Orthopters) and ıose of the Apipens, (Hymenopters, Dipters and Aphanipters,) nd Amplipens, (Lepidopters, Homopters and Trichopters,) ıaches that these subdivisions are *coördinates*, or of one grade. This is further indicated by other points of parallelism, namely, ıat the first subdivision of the Pterometasthenics and Apipens, ıe Hymenopters and Coleopters, have eminently the features ıch of a high type; and the last, the Aphanipters and *typical* 'rthopters, are alike metapodosthenic or saltatorial species. So lso under the Amplipens, the 2nd subdivision, or that of Ho- ıopters, is closely related to the second of Pterometasthenics, r that of Hemipters (page 27).

Hence, if the grander subdivisions of Apipens and of Ampli- ens are called tribes, those of the Pterometasthenics should also e so designated.

Under the *subkingdom* of Articulates, there are the *classes* of ısecteans, Crustaceans and Worms; and under Insecteans, the *·rders* Insects, Spiders and Myriapods.

If then the term *tribe* be used for the familiar groups, Hymen- pters, Dipters, &c., as just suggested, the question comes up as the designations of the two intermediate grades of groups be- reen *orders* and *tribes*.

The distinctions on which they are based are so obviously or- nal that they may be well called orders of subordinate grades; ıd I propose for the first of the two the designation *suborders*, ıd for the second *ordinules*, a diminutive of *orders*. The stages ill then be as follows.

Orders: Insects, Spiders, and Myriapods.
Under *Insects*—

Suborders: 1 Pteroprosthenics, 2 Pterometasthenics, 3 Thysanures.

Ordinules (confined to the Pteroprosthenics): 1 Apipens, 2 Amplipens, 3 Attenuates or Neuropters.

	Apipens.	Amplipens.	Attenuates.	Pterometasthenics.
Tribes,	1. Hymenopters.	Lepidopters.	Apipenniforms.	Coleopters.
	2. Dipters.	Homopters.	Amplipenniforms.	Hemipters.
	3. Aphanipters.	Trichopters.	Perattenuates.	Orthopters.

The subdivisions of the three tribes under the Attenuates or Neuropters, (p. 22,) and those of the tribes of Orthopters, (p. 24,) may be all designated *subtribes;* there is in the two higher of each a like reference to the *higher* tribes of Insects.

This subject will come up again for further discussion. But, for comparison, I allude here to one other department of animal life—that of Mammals.

The *orders* of the *class* of Mammals, as explained in former papers, are (1) Man, (2) Megasthenes, (3) Microsthenes, (4) Oötocoids; and in the distinctions between the highest of these orders, there is an example of the *retroferent method*, case *a*, as in the distinctions between the *highest* of the orders of Insecteans. Hence there is reason for concluding that the orders of Mammals and those so-called of Insecteans are actually all *orders*, or are groups of coördinate value. See further on this point, page 350, Art. I.

Under these orders of Mammals, (a class few in species), there are no *suborders* or *ordinules;* the next grade of groups is that of *tribes*, namely, as explained on page 341, of Art. I:—I. Under *Megasthenes*, (1) Quadrumanes, (2) Carnivores, (3) Herbivores, (4) Mutilates; II. Under *Microsthenes*, (1) Chiropters, (2) Insectivores, (3) Rodents, (4) Edentates. There appears to be no occasion for doubting that these subdivisions are coördinates with the *tribes* of Insects. As groups they stand out before the eye and mind of the zoologist with similar prominence and distinctiveness in their respective subkingdoms.

Geological History.—The memoir of A. S. Packard, Jr., which has afforded so many convenient illustrations of our subject, aims especially to show that Neuropters are remarkable among Insects for their many relations to the other tribes, or for the number of "synthetic" types which they embrace. The classification explained throws into their natural relations these affiliating groups, and shows that the many interlinkings are dependent on the position of this tribe as the lowest or hypotypic group of Pteroprosthenics, and its correspondence in grade with the Orthopters or the hypotypic group of Pterometasthenics.

But there is further reason for the many analogies, in that the *Neuropters* and Orthopters, while at the base of their respective

grand divisions, lead off apparently in geological time the Insects of the globe—the Neuropters the pteroprosthenic, and the Orthopters the pterometasthenic, Insects.

In view of this fact, we should naturally expect to find among the early representatives of these tribes foreshadowings of the higher tribes of Insects, that is, comprehensive (or synthetic) types embracing some of the characteristics of those higher tribes. Now two of the subdivisions of both Neuropters and Orthopters, in the classification proposed, consist mainly of such comprehensive types, and these were the forms which were apparently most characteristic of the Carboniferous Insect-fauna: namely, Termitideans or the Hymenopteroids and Planipennians or the Lepidopteroids, among Neuropters; and Cursors or the Coleopteroids and Ambulators, among Orthopters. With these there were also the typical Orthopters or Saltators, (Crickets being among Carboniferous species,) and possibly also Coleopters. Nothing is yet known of ancient Thysanures, although it is probable they were in existence at the same time.

We should expect also from the association of the Neuropters and Orthopters in the same Carboniferous fauna that there would be examples of intermediate types between these tribes, that is, those which, while related fundamentally to one of the two tribes, presents some characteristics of the other; for in this way the striking harmony in the flora or fauna of an age in geological history was often produced,—as, for example, in the land-vegetation of the Carboniferous era, which embraced common Acrogens (Ferns) and Gymnosperms; and besides these, the intermediate or comprehensive types of the Lepidodendra and Calamites of the former, and that of the Sigillariæ of the latter. And thus it was in fact. The Insect from the Carboniferous rocks of Illinois, figured and described in the following article, is one example of a comprehensive type of this kind. While Neuropterous in wings, closely approaching the *Semblids*, it has broad costate femurs, and even a large spinous joint to the anterior legs, peculiarities which seem to be almost inconsistent with the Neuropterous type, although in part characterizing the *Mantispids*, and which are in complete harmony with the Orthopterous type.[*]

We here see that the interlinkings between Orthopters and Neuropters began in the Paleozoic. It is probable that such comprehensive or intermediate forms were more numerous in the past than they now are.

[*] The Orthopterous features among Neuropters appear to be modifications of form under the types in this group which have been already mentioned, especially the Lepidopteroid, and not indications of a distinct type of *Orthopteroid* Neuropters. The fossil species referred to, and also the modern Mantispids, are true *Planipennians* in their wings and in their other characteristics of special importance. They properly constitute an Orthopteroid group in this subtribe.

ART. III.—*On Fossil Insects from the Carboniferous formation in Illinois;* by JAMES D. DANA.

The remains of Insects, represented in the following figures, were discovered by Mr. John G. Bronson in the Carboniferous beds at Morris, Illinois. They occur in the flattened iron-stone concretions of the beds. Other concretions of the locality contain various coal plants, and also the remains of two or three species of *Amphipod* Crustaceans. The plants have been investigated by Mr. Lesquereux and descriptions of them, we understand, will appear in the Report on the Geology of the State by Mr. Worthen. Among them, according to Mr. Lesquereux, the following are common species: *Neuropteris hirsuta* Brgt., *N. rarinervis* Brgt., *Pecopteris Miltoni* Brgt., *P. unita* Brgt., *P. æqualis* Brgt., *Annularia longifolia* Brgt. The description of the Crustaceans we reserve for another time.

1.

Figure 1 is twice the natural size lineally. In general form and the neuration of the wings the Insect is closely like the *Semblids* among the Neuropters, and especially, as I am informed by Dr. LeConte, the *Chauliodes*. In view of this resemblance, and also the fact that the outer wings are so thin as not to obscure at all the outlines of the abdominal segments, and hardly the inferior wings, there is no reason to doubt that the species was *pteroprosthenic*, and that therefore it must have been a *Neuropter*, and not an Orthopter. Yet in the broad costate femurs of the second pair of legs, and the form of the prothorax, it approaches the Orthopters of the Phyllium family, and is very unlike any known Neuropters. The anterior legs are peculiar in having a large and broad femur armed above with very slender spines as long as the joint, three

of which, though mutilated, are seen in the specimen. But something of this kind is observed under Neuropters in the *Mantispids.* It is quite probable that these anterior legs were prehensile, as in *Mantispa:* and the fact that the tibia and tarsus are not in sight in the specimen favors this conclusion. Only the left leg in the specimen has the large joint tolerably perfect; in the right, however, it is sufficiently distinct to show that it had the same large size and was also spiculigerous. The coxal joints of this leg, are faintly indicated between this large joint and the anterior part of the somewhat prolonged prothorax.

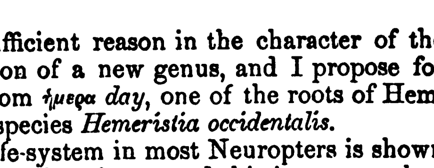
The number of abdominal segments is *ten*, or *one more than the typical number* in Insects—as is true also of many Neuropters, the Lepismæ, and some species of other tribes. The neuration of the wings and the form and relative sizes of the segments of the abdomen are well shown in the figure, and particular description is therefore unnecessary. There appears to have been a pair of short obtuse appendages at the extremity of the abdomen, much as in *Phyllium.* The head is mostly obliterated.

The length of the specimen, from the anterior margin of the large joint of the anterior legs to the posterior margin of the wings, is 1 inch 10 lines; and the breadth, from the medial line of the abdomen to the left margin of the left wing, 5 lines.

By request of the discoverer, I name the new genus here indicated, *Miamia,* after the Miami University, his "alma mater." In view of the important results of his explorations, the species may be designated the *Miamia Bronsoni.*

Figure 2 represents, natural size, a mutilated anterior wing of another Neuropter. The neuration approximates to that in the genus *Hemerobius.* The dotted line shows the probable length and outline of the wing—these organs in the Planipennians being 3 to 4 times as long as their breadth. The areolets are obliterated towards the base of the wing.

2.



There appears to be sufficient reason in the character of the neuration for the institution of a new genus, and I propose for it the name *Hemeristia* (from ἡμέρα *day*, one of the roots of Hemerobius), designating the species *Hemeristia occidentalis.*

The feebleness of the life-system in most Neuropters is shown in the numerous nervures of the wings; and this is very marked in this ancient species. The great multiplication of these nervures and their irregularity appears to be owing to a want of directive force in the system, or to a low grade of cephalization or *systemic control in the animal.*

ART. IV.—*The Density, Rotation and Relative Age of the Planets*; by Prof. GUSTAVUS HINRICHS, Iowa State University.

MODERN astronomers consider the doctrine of the *stability of the solar system*[1] as "a fact established on the most satisfactory evidence," and its demonstration as "among the finest triumphs of physical astronomy." Yet with all due regard to the grandeur of its analysis, the philosopher may question not its demonstration, but its *hypothesis*. For if the hypothesis of a vacuum should prove to be not fully true, if the planets instead of moving *in vacuo* suffer some, however slight a resistance in moving through *ether*, then the analytical demonstration loses its physical import.

The metaphysician, in contemplating the ardor wherewith this doctrine is advocated cannot but see in it a more refined form of the doctrine of ancient philosophy that the earth is about equal to the universe; and the theologian might find the stability of the planetary system opposed to the prediction that nothing is eternal here below.

Yet this is not the place to decide the latter questions; we will simply investigate how far the assumption of a vacuum—or, if possible, a non-resisting medium—agrees with observation. It is true, the ephemeris based upon it proves to be correct; accordingly, both Newton and Laplace have pronounced the resistance, if any, to be insensible. But in the doctrine of the stability of the solar world hundreds of centuries, aye, millions of years are contemplated; is then the conclusion drawn from a few centuries of observation legitimate for such duration of time? Is it any more legitimate than to deduce the orbit of a comet from one hour's observation? or the path of our earth from one second's observation? To pronounce on the ground of accurate observations of limited extent, the solar system a stable, i. e., an everlasting one, is hardly better philosophy than that of the little insect in the fable, who believed the day to be everlasting because the sun seemed exactly at the same height during all its life.

There is but *one* method of judging of the stability of the solar system, and this consists in comparing the state of the system now with what it was millions of centuries ago; for a thousand years in nature are but as yesterday when it is past, and as a watch in the night.

It will be objected that it is impossible to effect this. If so, we must abandon the theory of stability, for want of confirmation by observation. But if we wish to test the doctrine as

[1] Olmsted's Astronomy by Snell, § 384.

far as possible, then we must accept a different course of investigation. We must do for astronomy what geology has done for geography—in the absence of records from the earlier stages of the earth's history it has been successfully attempted to supply them by *observations on the configuration* of the earth's parts, carefully compared with the yet continuing changes thereof. We must try to investigate the different *celestial strata*, try to see whether they are in situ or displaced, and, if displaced, measure the force which produced the dislocation: then we will obtain as good *determinations of the relative age of these celestial strata* or planets and moons as geology affords for the relative age of *terrestrial strata*.[1] As far as Induction is to be relied on in *geology* it may safely be relied on in astronomy, and we hope to show that the known observed configuration of the solar system gives, by means of the calculus and a strict induction, as good a determination of the relative age and the resisting forces as geology can produce in regard to the earth's crust. If then geology, notwithstanding its yet leaving many questions undecided, is considered more than idle speculation, we hope to vindicate the same confidence for the results of this investigation into the nature and effects of the dislocating force of the solar system: we will try to show that the *resistance of the ether* filling the heavenly spaces is this force.

First, it may be well to remember that the undulatory theory is so well supported by experience as to place the existence of such a resisting medium almost beyond doubt. Secondly, that the comet of Encke seems to show observable signs of such a resistance. Finally that the absence of positive signs of resistance in the observed motions of the planets does not prove its non-existence; for if the earth approaches the sun by ten feet every year, this resistance could not be said to be nothing—yet, assuming Kepler's third law as applying to the same planet in different distances, we easily find that the year would be shortened only *one second in a thousand years* by this resistance! If this quantity is imperceptible, resistance is; but the latter cannot on that account be considered as nothing!

Let us therefore investigate the laws of such a resistance and try, whether the configuration of the heavenly strata affords that confirmation of it which the ephemeris does not.

I. *The effects of Resistance.*

Let r be the radius vector, θ the anomaly, t the time, η the angle between the orbit and a perpendicular to the radius vector, and R the accelerating force due to the resisting medium; then

[1] See an example in Dana's *Manual of Geology*, p. 386, where the relative age of the Silurian, Devonian, Carboniferous, is found to be as 3 : 1 : 1.

resolving the forces into a radial and transversal component we obtain the general equations[3] of motion:

$$\left.\begin{aligned} \frac{d^2r}{dt^2}-r\left(\frac{d\theta}{dt}\right)^2 &= -\frac{\mu}{r^2}+\mathrm{R}\sin\eta, \\ \frac{1}{r}\,\frac{d\left(r^2\frac{d\theta}{dt}\right)}{dt} &= -\mathrm{R}\cos\eta. \end{aligned}\right\} \qquad (1)$$

We might integrate (1) by the methods of approximative integration, as Laplace has done in a similar case; or we might integrate for R=0 and use the variation of parameters. This latter method would be much more appropriate than the first; yet we think that a simple successive approximation is fully exact enough and at the same time so much more elegant and easy that we will prefer it, considering uniformity to be a true element of any investigation. We therefore directly aim at just that degree of approximation which observation enables us to test—and also thereby keep this paper within the range of almost every student of the calculus.

The *first approximation* gives Kepler's laws as the integral of (1) for R=0, representing the motions in vacuo:[4] i. e. respectively:

$$\left.\begin{aligned} r=\frac{a(1-e^2)}{1+e\cos\theta}, \qquad r^2\frac{d\theta}{dt}=c, \\ \mu=4\pi^2\frac{a^3}{\mathrm{T}^2}=\frac{c^2}{a(1-e^2)} \end{aligned}\right\} \qquad (2)$$

I. The orbit is an ellipse;

II. The radius vector of *any planet* describes equal *areas* in equal times;

III. The mean radii vectores (*mean distances*) of the several planets describe in their *mean motion* equal *solids* in equal times.[5]

[3] These formulæ are easily obtained as stated; compare Price, *Infinit. Calculus*, vol. iii, Art. 297, formula (174), remembering that $\mathrm{P}=$ gravitation $=-\frac{\mu}{r^2}$, $\mathrm{Q}=0$ $\sin\eta=\frac{dr}{ds}$, $\cos\eta=\frac{rd\theta}{ds}$, and as a simple identity

$$2\frac{dr}{dt}\frac{d\theta}{dt}+r\frac{d^2\theta}{dt^2}=\frac{1}{r}\left(\frac{2rdr}{dt}\frac{d\theta}{dt}+r^2\frac{d^2\theta}{dt^2}\right)=\frac{1}{r}\cdot\frac{d\left(r^2\frac{d\theta}{dt}\right)}{dt}.$$

[4] The first and second are of familiar form; the third may be found in Price's *Calculus*, vol. iii, Art. 331, where h is used for our c.

[5] This new form of the third law shows it to be analogous to the second; the latter characterizing the individual in its *actual motion*, the former the genera in the *mean motion* of the individuals. I found this form whilst searching for the harmony between these two laws, and used it as early as 1857 in public lectures on the prin-

For obtaining a *second approximation*, we remark that the first 2) easily gives the maximum of η corresponding to $\sin\eta = e$. Hence, for the planets, all having but a very small excentricity, the terms $R\sin\eta < Re$ nearly equal zero and $R\cos\eta$ nearly equal R are of different order; the latter will be of influence when the former is yet insensible. As a second approximation giving the the influence of resistance in general, we therefore may take $R\sin\eta = 0$ in (1) giving[6]

$$\left.\begin{aligned} &\frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2 = -\frac{\mu}{r^2}, \\ &\frac{1}{r}\frac{d\left(r^2\frac{d\theta}{dt}\right)}{dt} = -R\cos\eta. \end{aligned}\right\} \qquad (1')$$

Finally, a third approximation would likewise take the yet neglected term $R\sin\eta$ into account; but this is in the present state of science altogether worthless, as observations but imperfectly suffice to test our second approximation.

In order to integrate (1′) the function R must be known. It is admitted that, φ being a function of the velocity v and ν a certain constant,

$$R = \nu\,\varphi(v). \qquad (3)$$

According to Newton (*Principia*, Book II, Sect. VII; Francœur *Mécanique*, 5 éd, art. 223), we have for a sphere of radius ϱ, density Δ moving in a medium of density δ,

$$\nu = \frac{3}{8}\frac{\delta}{\varrho\Delta}. \qquad (4)$$

The function φ is generally taken as v^2; but the very accurate experiments of Giulio[7] prove that for small velocities of the

ciple of the *beautiful* as a means of investigating the laws of nature instead of the *true* or mathematics.

To show the correctness of our expression we simply introduce the mean velocity $V = 2\pi\frac{a}{T}$; for thereby the third (2) becomes

$$\mu = 4\pi^2\frac{a^2}{T^2}a = aV^2,$$

i. e., the right cone of radius V and altitude a is of constant volume.

[6] It is easily understood that neglecting $R\sin\eta$ is the same as assuming the excentricity to be constant. As e now is very small, and Laplace (*Méc. Cél.* Liv. X, chap. VII, § 18) found it to decrease with the approach of the planets to the sun, since he obtained

$$e = \text{constant}\sqrt{\frac{a}{\text{density of ether}}},$$

our second approximation will be more close for future than for past ages.

[7] In 1853; as most of my books are yet in Germany, I cannot cite the memoir of Giulio in particular; my abstract at hand only gives the principal results of his investigation.

pendulum the resistance is principally proportional to the velocity itself, for greater velocities, to its square, or more exactly

$$\varphi(v)=av+bv^2. \qquad (5)$$

Now, as the resistance under consideration is excessively small, the form of φ will be very nearly

$$\varphi(v)=v. \qquad (6)$$

Introducing these laws (6) and (4) into (3) the equations (1′) for the second approximation become

$$\left.\begin{aligned} &\frac{d^2r}{dt^2}-r\left(\frac{d\theta}{dt}\right)^2=-\frac{\mu}{r^2}, \\ &\frac{1}{r}\frac{d\left(r^2\frac{d\theta}{dt}\right)}{dt}=-\nu v\cos\eta. \end{aligned}\right\} \qquad (1'')$$

The first of these is satisfied by the elliptical orbit of each single revolution; the second, since $v\cos\eta=\frac{rd\theta}{ds}\cdot\frac{ds}{dt}=\frac{rd\theta}{dt}$, reduces to

$$\frac{d\left(r^2\frac{d\theta}{dt}\right)}{dt}+\nu\left(r^2\frac{d\theta}{dt}\right)=0; \qquad (7)$$

which, by the second (2) expressing the conservation of the areas, becomes the simple equation

$$\frac{dc}{dt}+\nu c=0; \qquad (8)$$

giving, if $c=C$ for $t=0$, and ε the base of the natural logarithms,

$$c=C\varepsilon^{-\nu t}. \qquad (9)$$

By the third law of Kepler, i. e. the third of (2) or $a=$ constant times c^2 we have

$$a=A\varepsilon^{-2\nu t}. \qquad (10)$$

if A be the value of a for $t=0$. Thus the distance from the sun does not decrease uniformly, but with a velocity proportional to the decreasing value of a, for

$$\frac{da}{dt}=-2\nu A\varepsilon^{-\nu t}=-2\nu a. \qquad (11)$$

If t expresses the present age, distance a, and x the distance corresponding to an age differing from the former by ϑ units of time, then (10) gives

$$x=A\varepsilon^{-2\nu(t+\vartheta)}=a\varepsilon^{-2\nu\vartheta}. \qquad (10')$$

giving the distance as a function of its present value a and the interval of time from the present. As the unknown density δ enters into ν, we may instead of (10,) use the following,

$$\log x=\log a-\frac{\vartheta}{\varrho\Delta}, \qquad (12)$$

e the unit of a is arbitrary and that of ϱ and Δ may be as-
d if the unit of ϑ is determined in conformity therewith.
hen may take for our earth $a=100$, $\varrho=10$, $\Delta=1$; then the
of ϑ will be known as soon as the amount of resistance or
lensity of the ether is given. Neither being exactly known,
nust be satisfied with an estimate; and thus (12) easily
rs[8] that *if our earth approaches the sun annually by ten feet, the of age ϑ is ten thousand millions of years.*

will be seen that, as soon as the annual approach of our
1 is known, the unit of ϑ will be determined.

y means of (10′) or its equivalent (12) we are now enabled
lculate the effect of resistance on the motions of any planet
ny age ϑ, both in future ($+\vartheta$) and the past ($-\vartheta$). We now
eed to a comparison of the results of this analysis with ob-
ation, using the following data[9]

	a	ϱ	Δ	$\frac{1}{\varrho\Delta}$	
ury,	38	3·9	1·23	·2	
is,	72	9·98	1·07	·1	
1,	100	10·00	1·00	·1	
,	152	5·14	·96	·2	
roid,				10·0	(assumed.)
er,	520	114·4	·24	·04	
rn,	954	94·8	·14	·08	
ius,	1918	45·8	·18	·13	
une,	3004	42·5	·23	·1	

ng by (12) the following distances from the sun at the ages
cated.

	Past.		Present.		Future.	
:	4	2	0	2	4	6
ury,	240	95	38	15	6	2
is,	181	100	72	45	29	18
1,	252	159	100	63	40	25
,	955	381	152	65	24	9
er,	725	626	520	433	360	299
n,	1991	1378	954	660	454	316
us,	6351	3490	1918	1078	593	326
une,	5985	4237	3004	2127	1504	1066

n asteroid for which $\varrho\Delta=\cdot1$,

	·4	·2	0·0	·5	1·0
nce,	1770	770	280	28	3

or $a=95{,}000{,}000 \times 528$, or about 50,000,000,000 ten-feets, hence $a-x=$ 9,999,999 ten-feets; consequently by (12)

$$\vartheta=\varrho\Delta\log\frac{a}{x}=10\log\frac{50000000000}{49999999999}<0{\cdot}0000000001,\ \vartheta \text{ being 1 year};$$

$\vartheta=1$ for 10000000000 years.

[C]osmos, Harper's ed., iv, 119; the density of Venus as given by Babinet, *[Inst]itut*, 1857, p. 94.

These numbers are represented in the annexed diagram, which thus shows the variations in the distance of the planets.

As the configuration of the solar system hereby appears to be continually changing in time—even the order of sequence suffering alterations—it is idle to speculate concerning "the harmony of the heavens" without taking the element of resistance into account; for it is obvious that the true primitive law, which alone can have been harmonious, will long ago have been profoundly modified by the continued action of resistance.[10]

In order to make a useful application of this table, permitting the test of actual observation to be applied to the results deduced, we will try to estimate the relative age of the planets by means of these modifications in their position.

The dislocation of strata of rocks is no *fact;* we simply see similar parts in irregular position, and *conclude by induction* that they once formed a continuous stratum; but would it not be equally just to conclude that *the heavenly strata*, i. e., *the planetary orbs, are dislocated*, if we can show that, 1st, *they approach to a definite law*, as the terrestrial strata in being parallel;

2nd, *The assumption of the force of resistance fully explains the deviations from that law*, as the assumption of internal action explains the dislocation of geological strata?

We think the analogy is about as close as can be, and therefore will venture the attempt.

It is a well known fact that the so-called law of Titius or Bode, is pretty correct for all planets from Venus to Uranus; only Mercury and Venus deviate considerably from the *duplication of the successive mutual distances.* This law—only in the case of Mercury deviating from the above named—may therefore well be compared to the original level of terrestrial strata, if the laws of resistance as developed in the preceding suffice to explain the actual deviations from it.

It is even *a priori* highly probable that some simple law prevailed at the time of the development of the heavenly spaces, although it is now almost entirely lost; for in like manner the regular stratification of the earth's crust has been disturbed —so the regular distribution of the leaves in the young plant is almost entirely lost in the arrangement of the branches of the tree—so even the human features lose their regularity by age. Yet in all cases matter seems to arrange itself according to simple laws; as we see it in the minute crystal, we must infer it for the heavenly spaces.

[10] Plato, in *Timæus*, simply estimated the distances—having no means of testing his estimates by observation; Kepler also speculated much on the law of planetary distances, and gave as his final opinion that "*the old planets are altered a little in position.*" (Humboldt, *Cosmos*, iii, 440; Harper's edition, iv, 110.) This seems to be another instance of Kepler's divination of scientific results.

Taking now x according to this law as the original distance, we find the age ϑ by (12), viz:

	Distance.[11]	Age.		Distance.	Age.
Mercury,	60	1·0	Jupiter,	680	3·0
Venus,	80	·5	Saturn,	1320	2·0
Earth,	120	·8	Uranus,	2600	1·0
Mars,	200	·6	Neptune,	5160	3·0
Asteroid,	360	?		Mean age,	2·25
	Mean age,	·72			

Although there is considerable variation in each separate group, *the mean gives a decidedly higher age to the exterior planets than to the interior ones, about in the ratio of one to three.*

But if this law is correct, it demands that *the relative age of the planets increases with their relative distances from the sun* (supposing no interchange of place yet to have occurred). Consequently our determination of the age of the single planets appears to be very uncertain, since Jupiter figures with the same age as Neptune! But it is easy to show that this is simply a consequence of our taking ν constant, whilst it not only is greatly varying, but even varying in different degrees for different planets. For, considering δ as constant,[12] and for a certain former period $\varrho = n\varrho_{\prime}$ ($\varrho_{\prime}$ being the present value of ϱ), the constancy of the mass gives $\varrho^3 \Delta = \varrho^3_{\prime} \Delta_{\prime}$ or $\Delta_{\prime} = n^3 \Delta$, i. e.

$$\nu = \frac{3}{8} \frac{\delta}{\varrho \Delta} = \frac{3}{8} \frac{\delta}{\varrho_{\prime} \Delta_{\prime}} n^2 = \nu_{\prime} n^2, \tag{13}$$

or, *the greater the body, the greater is the value of* ν, as is self-evident. If now all planets had exactly the same masses, their cooling or condensation would be entirely parallel, and ν might be considered as nearly constant; but as there are great differences between the masses of the planets we must remember, that, cæteris paribus, *the larger mass* cools slower, i. e. keeps longer the greater value of ν corresponding to its longer remaining of larger size; it will consequently fall with a greater velocity than calculated on the supposition of ν constant, or, what is the same, will have a *smaller age than calculated.*

We must therefore apply a subtractive *correction* to our calculated age increasing with the mass of the planet. By doing so in general we found the equations of condition pretty well satisfied by taking this correction *proportional to the mass.* For the superior planets we may have (the constant being assumed 0·1)

[11] These distances seem to afford a good average; the law is rigorously applied, for 80 − 60=20, 120 − 80=40=2·20, 200−120=80=2·40, etc. The series is,

$m, m+n, m+2n, m+4n, m+8n$, etc.

[12] It is probable that δ is not constant, either in time or in space; the only means for trying it will be to see whether the velocity of light remains constant in time, whereby we are carried through different parts of the heavenly space (aberration).

	Mass.	Age.	Correction.	Corrected Age.
Jupiter,	25	3	2·5	·5
Saturn,	7	2	·7	1·3
Uranus,	1	1	·1	·9
Neptune,	2	3	·2	2·8

This is already a much more regular series; the mean of the corrected ages for Jupiter and Saturn is ·9, for Uranus and Neptune 1·8, or, whilst the uncorrected age of the former was greater than that of the latter, by this (very imperfect) correction for mass it is as *one* of Jupiter-Saturn to *two* of Uranus-Neptune. The conclusion seems therefore well-founded, that a *more thorough investigation of the variation of ν in time, if possible at all, would give the age of the different planets as regularly increasing with their distance from the sun.*

This result is in itself already important; but it also gains much by its connection with the following considerations.

Now, as the outer planets are older than the inner ones, we must find the different parts of our solar system in very different conditions of age: and this again may be tested by direct observation. By attentively contemplating the annexed diagram, representing the effect of resistance or time on the configuration of our solar system, we shall find the following four laws:

First Law. The nearest secondary approaches its primary with advancing age.—Expressing these distances in radii of the central body, we have:

Mercury,	80	rad. of the Sun.
Moon,	60	" " " Earth.
Jupiter, 1st Moon,	6	" " " Jupiter.
Saturn, 1st Moon,	4	" " " Saturn.

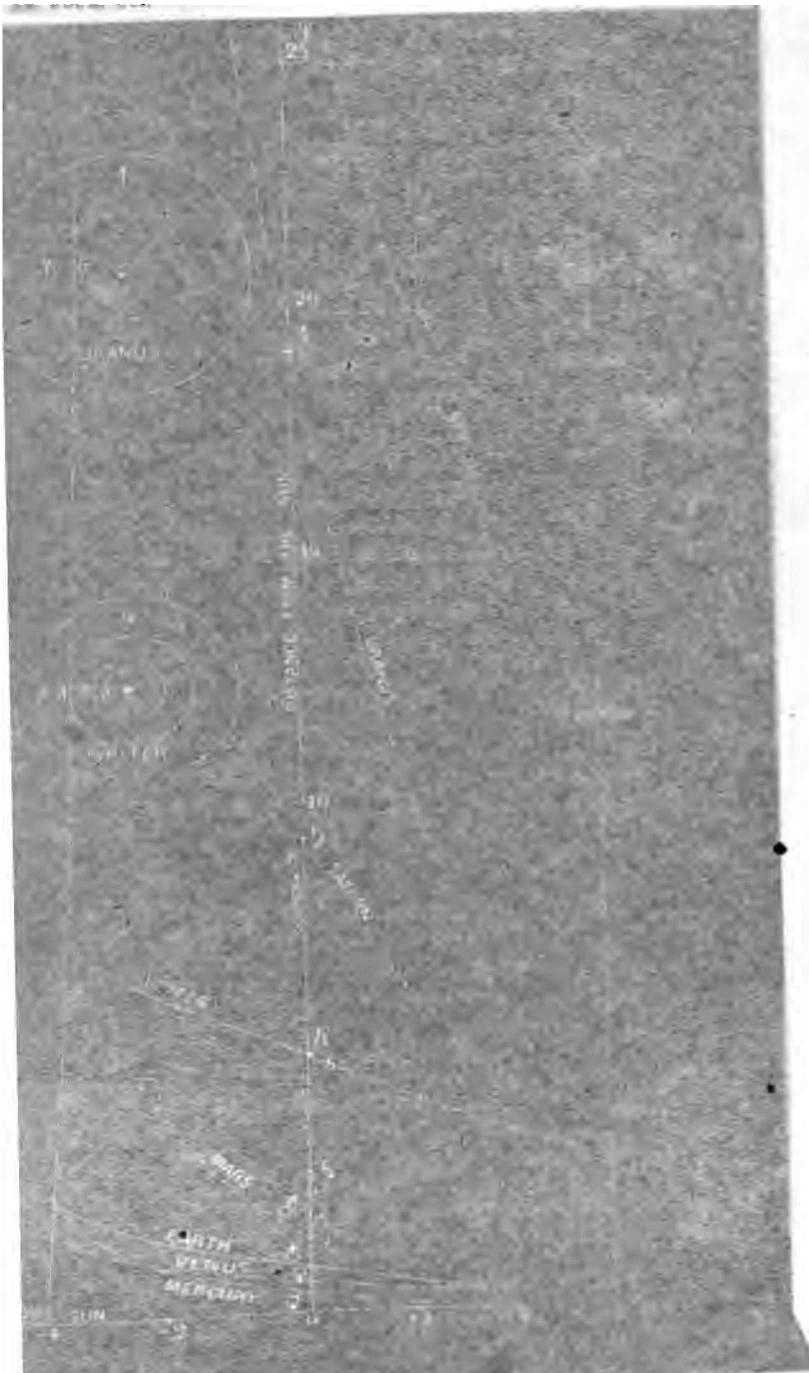
thus showing a decrease with age. Uranus, having its moons differently situated, is not comparable. Yet it must not be omitted, that this mode of comparison is not free from objections. The subsequent three laws are, however, nearly absolute.

Second Law. The entire system of orbits becomes closer by advancing age.—The ratio of the mutual distances will be the most proper measure of the closeness. We have:

Nept.-Ur.	=1·115	Ur.-Saturn.
Ur.-Sat.	=2·247	Sat.-Jupiter.
Sat.-Jup.	=1·718	Jup.-Asteroid.
Jup.-Ast.	=2·195	Ast.-Mars.
Ast.-Mars	=2·195	Mars-Earth.
Mars-Earth	=1·892	Earth-Venus.
Earth-Venus	=·824	Venus-Mercury.

hence the mean ratio for the

World of the Sun	1·74; similarly for
" " Jupiter	1·8
" " Saturn	1·3
" " Uranus	·9


MARS
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which numbers regularly decrease with the increasing age, confirming the law.

Third Law. The regularity and symmetry disappears more and more with increasing age.—A single glance at the representation of the actual forms of the lunar systems of Jupiter, Saturn and Uranus shows that these latter are very irregular, whilst the lunar world of Jupiter, the youngest of this group, is as yet very regular.

Yet the distances of its moons is not quite regular; for they are, expressed in radii of the planet respectively

6·049 9·623 15·350 26·998.

As Jupiter is proved to be older than the interior planets, and as these exhibit signs of age in their mutual distances, the face of old Jove can neither be without wrinkles. Indeed, perceiving that the same law of duplication is applicable to the above distances, and selecting as the primitive values

$7 \qquad 7+3=10 \qquad 10+6=16 \qquad 16+12=28,$

we get by the known dimensions of these moons the following relative ages:

1 8 13 7

which, as the third has as much mass as the other three taken together, by the reduction for masses, would become more regular; yet we see that the mean age of the last two satellites is twice as great as the mean age of the first two. Therefore we must likewise conclude that *the age of Jupiter's satellites increases with their distance from the primary.*

If the masses and dimensions of the members of the more distant worlds were known, we should certainly find this law of the age increasing with the distance from the central body to be universal.

Fourth Law. Similar systems must represent the same configuration at corresponding ages.[13]—Having found the more distant planets to be the older members of the solar system, and consequently that they are in a state of configuration which the solar system *as a whole* can first exhibit only at a future time, we are enabled to put the theory of resistance to another test by comparing the present configuration of the lunar worlds of the superior planets to different future epochs of the solar world as given by the diagram expressing the results of formula (12).

We have already seen that the Jovial World indeed appears very regular, and that the smaller regularity of the more distant worlds confirms our result as to their higher age.

At what age will the configuration of the solar system correspond to the present configuration of the world of Saturn? The diagram gives the *fourth age* as answer. For at that time we have the following similarity between the two systems:

[13] For if in (12) ρ, a, Δ and χ are multiplied by a constant n, ϑ becomes $n\vartheta$.

The *Rings of Saturn* are represented by the hosts of asteroids, which already in the first age intersect the orbit of our earth, but in the fourth age will closely encroach the sun, and (perhaps together with those meteorites which are not intercepted by any of the planets) may form continuous rings around the fiery sun, either on account of their number, or because they probably will become melted; they will form not one ring, but *rings*, because they will approach the sun according to the amount of their factor ν, just as detritus is deposited in horizontal layers of variable fineness.

The *four inner moons of Saturn*, being very close to each other and to the primary, will be represented by the four *interior planets*, for these also are at the fourth age very close together and very near the sun, being altogether within the present distance of Mercury. The distances are, then, for the planets [see results of (12)]:

Mercury 6, Mars 24, Venus 29, Earth 40;

for the Moons of Saturn, *now*,

Mimas 3·36, Enceladus 4·31, Tethys 5·34, Dione 6·84

or whilst the planetary distances will be as

1 : 4 : 5 : 7,

the corresponding lunar distances are *now* as

3 : 4 : 5 : 7,

or only differing in the first number.

The four outer moons of Saturn, now, correspond in configuration to the four exterior planets at age four; for the first three of each are about equidistant, the fourth far above the rest. The distances of the planets then are

Jupiter 360, Saturn 454, Uranus 596, Neptune 1504,

and of the moons are now

Rhea 9·55, Titan 22·14, Hyperion 28·00, Japetus 64·35,

or the relative distances are,

for the Planets as 7 : 9 : 12 : 30,
for the Moons as 4 : 9 : 12 : 26,

again a very close harmony.

A *complete* correspondence would demand a *complete similarity* of masses at the commencement, which perhaps is not to be expected. Comparing the better known superior bodies more in particular, we must from the smaller distance (4 instead of 7) of Rhea conclude, that its mass is *not* correspondingly as great as that of Jupiter; and for Japetus that its mass is not as great as the corresponding one of Neptune, or perhaps Hyperion must be comparatively of small mass, so as to leave Japetus far behind; this latter circumstance appears to be actually the case.

For in the first place Titan was the first moon which was seen (Huyghens, 1655), so we may conclude its mass to be great enough to afford a safe comparison with Saturn in the scale of Planetary Masses. *Rhea*, first discovered by Cassini (1672), therefore appears to be less considerable, confirming our conclusion based on its comparatively too great dislocation; and finally *Hyperion* required for its discovery the best telescopes of modern times (Bond and Lassell, 1848), thus proving itself to be but a small moon.

Thus the configuration of the lunar world of Saturn corresponds to the fourth age; consequently, as Uranus has been found to be older, its world must correspond to a yet more distant period of the planetary system as a whole. This is likewise evident by a similar comparison. Our diagram shows how Saturn and Uranus soon after the sixth age will come inside the path of Jupiter, and leave Jupiter and Neptune far above all the other planets. Just so we see the present configuration of the lunar world of Uranus to be. But as this lunar system is but very imperfectly known, we must be content with this general remark.

Thus it appears that all is confusion, no where is harmony in the planetary and lunar distances, if we disregard the effects of resistance; but that the whole solar world, both in its planets and moons, its asteroids and rings, is one grand whole, first built according to the principles of law and harmony and beauty which we observe everywhere in nature, in crystals, young[14] plants and animals. So likewise in geology all is confusion if we consider the strata in situ, as they are observed to be *now;* but this chaos gives way for harmony and symmetry if we admit the strata to be broken and dislocated by the action of the fiery interior of our globe. Therefore we have no better reasons to admit the dislocating force in geology, than for admitting the *resistance of ether* in astronomy. If we sometimes see the one force yet in actual violent operation, we must remember that its best criterion consists in its *slow,* almost imperceptible action for uplifting or depressing continents; and although the effects of resistance are infinitely smaller, yet they appear tolerably distinct in Encke's comet.

We rely on inductive reasoning in the explanation of the facts observed in the one case—why, then, not as well in the similar case afforded by the more grand dislocation of the strata of the universe?

Of course, we would not refer this to practical astronomy, for the ephemeris is exact enough without taking this resistance into account; but in theoretical astronomy, when discussing the *stability of the solar system*, I think it has been shown that this force ought not to be omitted.

[14] *The regular development of the yolk of eggs* by segmentation is especially *instructive in this connection.*

II. *The Laws of Density and Rotation.*[15]

It has been shown that the age of the several members of a system of heavenly bodies increases with the radius of the orbit. This seems to be sufficient proof for the natural development of the entire planetary system. Hence the question may arise as to the mode of this development.

The striking *unity* of the system, as displayed in the conformity of all the primary revolutions with the rotation of the sun, both in direction and plane; the smallness of the excentricities and the great mutual distances of the several orbits; the perfect analogy between the systems of different order—all these very elements of the *comparative stability*[16] of our planetary world compel us to conclude with Kant[17] and Laplace[18] that *all the members of the entire system once formed a single, large nebulous globe, rotating around the present axis of the sun.*

The grandeur and simplicity of this view has procured for it advocates of the highest authority, as Arago,[19] H. C. Œrsted,[20] Helmholtz,[21] and others. Yet the minimum in density exhibited by Saturn, and above all the singular motion of the satellites of Uranus, appearing to be entirely at variance with the very fundamental principle of the theory, seem to have brought these views into disrepute; Brewster[22] even pronounces them to be "the dull and dangerous heresy of the age." The theory of a Laplace seems to have been abandoned without trying to reconcile it with Uranus—which planet was yet unknown at the time of the publication of the first edition of Kant's theory of the heavens—and even the beautiful experimental simile offered by Plateau's[23] researches on the equilibrium of fluids did but revive this theory for a moment.[24]

It will easily be seen that our estimate of the planetary ages, as based upon the resistance of ether and seen in the configuration of the several systems, fully agrees with the hypothesis of

[15] This part of the present paper was in part communicated at the meeting of Scandinavian Naturalists at Copenhagen, 1860; see *Forhandlinger*, 1860, p. 455.

[16] It needs scarcely to be remarked that we only opposed the *absolute stability* as taught by Laplace.

[17] Theorie des Himmels, 1755.

[18] Exposition du système du monde, 2d éd., Paris 1799, Liv. v, Chap. vi.

[19] Astronomie populaire, ii, 7, Paris and Leipzic, 1855.

[20] Naturlœrens mechaniske Deel; a text book of Natural Philosophy, used at the University and Polytechnic School of Copenhagen.

[21] Philosophical Magazine, 1856, xi, 489.

[22] Memoirs of the Life and Discoveries of Sir Isaac Newton, London, 1855, ii, 131.

[23] Mém. de l'Acad. de Bruxelles, vol. xvi, 1843, § 19-27.
Malgré la différence des lois que suivent les forces attractives dans ce cas et celui des grandes masses planetaires, nous avons vu se produire, en petit, une représentation frappante de la pluspart des phénomènes de configuration relatifs aux corps célestes, (§ 27).

[24] It affords me great pleasure to find an able advocate of this theory in Prof. *Kirkwood; see this* Journal, 1860, [2], xxx, 160-181.

Kant and Laplace, according to which the more distant members were first developed. Hence it seems to be worth the while attentively to trace out the consequences of this hypothesis in an analytical form, as only thereby it will appear, whether the planet Uranus disagrees with the theory itself, or simply with the deductions of its advocates.

The Density Δ of the planets must depend, according to this theory of evolution *and condensation*, both upon the distance r in the original globe *and* upon the condensation in time, i. e. *the age* ϑ; as the density was *decreasing* from the center of the nebulous globe, and is increasing in time, we have obviously

$$d\Delta = \frac{d\Delta}{d\vartheta}d\vartheta - \frac{d\Delta}{dr}dr \tag{14}$$

where the differential coëfficients represent positive, numerical values.

Thus it appears that the conclusion of a regularly decreasing density demands $d\vartheta=0$; indeed, so far as we are aware, nobody has as yet pointed out the influence of age on the density of the planets.

It is evident that, if the differential coëfficients of Δ in regard to age and distance are either only increasing or decreasing, *there will be but one point where* $d\Delta=0$; if not, there will be several. Thus, according to the nebular hypothesis the densities of the planets may form a series having one or more maxima or minima corresponding to $d\Delta=0$.

The simplest forms of (14) fulfilling the conditions of the problem is seen to be

$$d\Delta = \frac{m}{\vartheta}d\vartheta - \frac{n}{r}dr \tag{15}$$

which with the simplest possible constants gives the integral,

$$\Delta = 1 + \log\frac{\vartheta}{a}, \tag{16}$$

where now a, the mean distance, enters instead of r the radius vector, and $\Delta=1$, $a=1$, $\vartheta=1$ for our earth. In order to see how far this formula represents the actual circumstances, let us calculate ϑ from the known values of Δ and a; (16) gives:

	a	Δ	ϑ	Mean.
Mercury,	·38	1·234	·66	
Venus,	·72	?	?	·83
Earth,	1·00	1·00	1·00	
Mars,	1·52	·96	1·39	1·15
Jupiter,	5·20	·24	·91	
Saturn,	9·54	·14	·15	1·28
Uranus,	19·18	·18	2·89	2·89
Neptune,	30·04	·23	5·13	5·13

If we only take the column of means—having again neglected to take the difference of mass into account, and not having searched for the true formula, but only having accepted the most simple form (15) satisfying (14)—we see the age of the planets again regularly increasing with the distance, very nearly according to the law

$$\vartheta = 1 + \frac{r^2}{200}. \qquad (17)$$

Using these simple formulæ, the *density Δ has only one minimum;* for $d\Delta = 0$ gives by (16) and (17)

$$r = \sqrt{200} = 14{\cdot}2 \ldots. \qquad (18)$$

i. e., *about equally distant from Uranus and Saturn.*

It must be remembered that we did not try to give a useful interpolation,[25] neither do we pretend to have found the *exact law;* yet we think that we have shown, that the nebular hypothesis, if duly considered, is in complete accordance with experience. The contradiction between theory and observation so long insisted on appears to have been occasioned by neglecting the most important element of dynamics, time. This element makes the planetary density *increase*[26] after a certain minimum has been attained.

The Law of Rotation.—To find the velocity of rotation from the primary nebulous globe is undoubtedly most difficult; but if we wish merely to determine the *direction of rotation,* and not its amount, the following simple analysis will prove sufficient.

The principal part of motion in the planetary ring is parallel to the orbit of the future planet; hence the direction will be defined by its equatorial part.

Let then dm be the mass of a particle in the plane of the orbit, $a + \alpha$ and θ its polar coördinates, a the radius of orbit, Δ the density and v the velocity in the orbit; then

$$\xi = \frac{\alpha}{a} \qquad (19)$$

will always be but a small fraction at the time of rupture, since the ring passes through a process of condensation previous to it —and as the distance to the next planet is never greater than a, ξ will never exceed one half. Within each nebulous ring we may assume the density to vary according to

$$\partial = \Delta \pm \frac{\delta}{a}\alpha = \Delta \pm \delta\xi, \qquad (20)$$

[25] Such a formula is given by Babinet, *l'Institut*, 1857, p. 94. Yet for Neptune his formula

$$\Delta = 1{\cdot}2754 - 0{\cdot}2935\,.\,a + 0{\cdot}01831\,.\,a^2$$

gives a result deviating by 8 units from the true density.

[26] The density of Neptune is sometimes stated to be but ·14 or equal to that of Saturn; Humboldt, *Cosmos*, iv, 178 (Harper's) gives ·23 as the most recent determination.

so that according to this law the density at the sun would be $\Delta+\delta$, or δ is the decrease in density from the sun to the planet (in nebulous state). If we compare this law to that assumed in (15) we see that *$\delta=n$ or is constant.*

Always using the upper and lower sign respectively for the superior and inferior part of the ring, we find the *vis viva dw* of *dm*

$$dw=\mu a(1\pm\xi)^3(\Delta\mp\delta\xi)d\xi\, d\theta, \tag{21}$$

if we remember that our statement of Kepler's third law gives $\mu=av^2$ (see note on (3)). Retaining only the first power of ξ in the differential, but the second in the integral, we obtain

$$dw=\mu a[\Delta\pm(3\Delta-\delta)\xi]d\xi\, d\theta, \tag{21'}$$

or

$$w=2\pi\mu a\left[\Delta\xi\pm\frac{3\Delta-\delta}{2}\xi^2\right]+\text{const.} \tag{22}$$

The vis viva w_1 of the *superior* part of the ring (from $\xi=0$ to $\xi=\xi_1$) will produce *direct* motion; w_2 of the *inferior* part (from $\xi=\xi_2$ to $\xi=0$) will produce *retrograde* motion; hence the whole *vis viva producing direct rotation in the orbit* is $W=w_1-w_2$ or by (22)

$$W=2\pi\mu a(\xi_1-\xi_2)\left[\Delta+\frac{3\Delta-\delta}{2}(\xi_1+\xi_2)\right]. \tag{23}$$

As the mutual distance of planets increases from the sun we must suppose $\xi_1>\xi_2$, whereby the first parenthesis of (23) always will be positive; hence we have

$$\left.\begin{aligned} &W\underset{<}{\overset{>}{=}}0, \quad \text{for} \quad \Delta\underset{<}{\overset{>}{=}}c, \\ \text{if} \quad &c=\frac{\xi_1+\xi_2}{2+3(\xi_1+\xi_2)}\delta. \end{aligned}\right\} \tag{24}$$

Now, δ is most probably constant, as stated above; and ξ_1, ξ_2 being *ratios*, will likewise be at least nearly constant; hence c represents about the same quantity for all planets. Consequently (24) reads in words:

The rotary motion in orbit will be direct, zero, or retrograde if the primitive density Δ at the orbit was greater, equal to, or less than a certain quantity, c, depending on the position of the orbit in the ring (ξ_1 and ξ_2) and the variation δ of the density.

If $\delta=o$, then $c=o$, and consequently all planets would have a direct rotation, as hitherto assumed. But δ must according to all physical knowledge be some positive quantity, however small, as the density Δ in every globe of some extension increases toward the center; i. e, if Δ is at all greater than c it will be so near the center, and if at all less than c it cannot but be further from the center. Hence we may also read (24) in the following manner:

The planets near the sun, $\Delta > c$, *have a* DIRECT *rotation, which disappears at a certain distance from the sun* ($\Delta = c$) *and is followed by a* RETROGRADE *motion of all the more distant planets* (having $\Delta < c$).

The great discovery of Herschel, far from being opposed to the nebular hypothesis of Kant and Laplace, on the contrary affords a most interesting and decisive confirmation of it, and makes it even similar to a most remarkable proposition in the theory of gravitation. For in the latter the orbit will be an ellipse, a parabola or a hyperbola, according as the centrifugal force was less, equal to, or greater than a definite quantity; so here we see the direction of rotation determined in the very same manner. The motion of the moons of Uranus is consequently for the nebular hypothesis exactly what the nearly parabolic orbits of comets are for the hypothesis of gravitation. If the density Δ had been excessively small, all the planets might have been retrograde in their rotation, although they would have had a direct revolution.

The *velocity of rotation* depends upon W and the mass of a planet; we cannot here determine it. But we can show how the position of the axis of rotation will vary. For if—as is highly probable—the ring was not quite symmetric with regard to the plane of the orbit, then there will be a difference of vis viva W_1 between these two sides, tending to produce rotation around an axis in the plane of the orbit. Hence the position of the axis of rotation of a planet will be determined by

$$\tan i = \frac{W_1}{W}, \qquad (25)$$

i being the angle between the equator and orbit of the planet. As the direction of the axis W_1 only determines the position of the nodes of the equator, we must here consider W_1 as positive; W has been found to change sign at a certain distance in becoming negative; so that we see: *all planets inferior to Uranus have i acute, superior to Uranus i must be obtuse.* The determination of the exact position of the axis of Neptune[27] will therefore be of great importance as a test of this remarkable law.

Origin of the tangential force.—As now the contradictions between observations and the theory of Kant and Laplace prove to be but apparent, founded in the neglect of the theory by mathematicians; we may inquire into the *cause* of the primitive rotary motion of the nebulous sphere.

Attractive particles (m) alone cannot give rise to a couple of forces; neither can repulsive particles (μ) do it—but by the

[27] Humboldt gives $i = 34° 7'$ for Neptune, but does not state whether the motion is direct or not. It *must* be retrograde or $i = 145° 53'$.—*Cosmos*, iv, 181. (Harper's.)

mutual action of both kinds of particles there will arise a couple N in any plane x, y, equal to

$$N = \Sigma \frac{m\mu}{r}(x\eta - y\xi)\,[f(r) - \varphi(r)], \tag{26}$$

if x, y and ξ, η are the coördinates of m and μ, r their mutual distance and f and φ their laws of mutual action. Now this sum Σ of the couples for all particles in the universe can only be zero either by

$$x\eta - y\xi = o, \quad \text{i. e.} \quad \frac{\eta}{\xi} = \frac{y}{x}, \tag{27}$$

or

$$f(r) - \varphi(r) = o, \quad \text{i. e.} \quad f(r) = \varphi(r). \tag{28}$$

But (27) can only be satisfied if m and μ are in the same radius vector from the origin of the coördinates; hence (27) cannot be satisfied in general. Hence if we have

$$f(r) \gtrless \varphi(r), \tag{29}$$

then N *cannot be zero;* if $N_{,}$, $N_{,,}$ are the resulting couples for the other coördinate planes, there results a *force of gyration* in the matter filling space

$$G = \sqrt{(N^2 + N_{,}^2 + N_{,,}^2)} > 0, \tag{30}$$

which is always positive. Hence,

If the law of repulsive particles, φ, differs from the law of attractive particles, f, then a rotation will be produced.

The laws of magnetic and electric attraction and repulsion seem to be at variance with such an inequality, and even the principle that action and reaction are equal; but we may well remark that the slightest difference for any atomic distance would be sufficient, and that the grouping of several repelling atoms μ around one attracting atom m may well be consistent with a difference between action and reaction as taken in its usual signification.

If this non-identity of the two forces of material nature is admitted, we see a rotation of the nebulous matter to be a direct consequence of this inequality; by attraction the matter acquires a globular form, the effected rotation produces a flattening of the globe,—and from this moment the axis of rotation will remain stationary. By continued attraction the size diminishes, rotation increases in velocity, the flattening becomes greater, a ring is formed, producing a planet with its satellites, the whole system having motions and configurations, which conform to those observed in the actual world.

The formation of cosmical bodies now appears similar to the multiplication of cells or even to the reproduction of certain animals by division; only we must not forget, that the formation

of heavenly bodies is far more simple and less wonderful[28] than the well-known, daily observed development of organized beings; if observation forces us to admit the reality of such wonders, should not induction suffice for the simple material development of the heavenly globes?

It is often stated as a most conclusive argument for the whole theory of gradual development, that we are permitted directly to observe the working of nature in the case of the ring of Saturn. We believe that this is a great mistake; for Saturn being one of the oldest members of our system, it appears rather unreasonable to expect to see it yet in an embryo state: besides the rings are in their constitution totally different from what this theory leads us to expect; instead of being broad, they are very thin and narrow. The explanation given in the preceeding, that they are a host of Selenoids, corresponding to the present host of asteroids, is yet further substantiated by the circumstance, that Titan seems in mass to preponderate like Jupiter, and may well, like this latter body, have broken up the subsequent ring into small bodies which on account of their excessive smallness and the high age of Saturn, have already descended to the proximity of this body—as the asteroids will do in the course of about one age.

Finally, it may yet be remarked, that we believe we are able to account for the multiform phenomena of terrestrial magnetism by the friction of ether on the earth;[29] if this theory should be admitted as a true physical one, the magnetic needle would be directed by the force lost in resistance, or, to speak in conformity with the doctrine of the correlation of physical forces, the vis viva lost in resistance is converted into magnetism. The magnetic needle thus would afford a direct proof of the existence of this resistance, as the pendulum of Foucault attests the rotation of the earth.

We believe that our efforts have approached more or less to the establishment of the following conclusions:

1st. The negative evidence of the non-existence of a resisting medium, as afforded by the motions of the planets during the few centuries of accurate observations, is of no weight whatever in regard to durations of time like those contemplated in the theory of the stability of the solar system; hence it follows, too, that it is unreasonable to expect here that accuracy of numerical determinations which so highly distinguishes the predetermination of astronomical phenomena for shorter periods, but that the immensity of *time* here under consideration admits of no higher

[28] Of course; for organized beings are more or less cephalized, till in *Man* we reach a scale in creation where matter has become entirely subservient to mind!

[29] The only—yet very imperfect—exposé of this theory hitherto published, is *Der Erdmagnetismus als Folge der Bewegung der Erde in Aether.* Copenhagen, *1860.*

accuracy than the immensity of *space* in the estimation of the distances of fixed stars and nebulæ.

2d. The present configuration of the planetary system is without that harmony and order everywhere else observed when matter is aggregating (e. g. in crystals, etc.); we must therefore suppose, that the original harmonious configuration has been altered by the action of some general cause, displacing the celestial strata (orbs) according to the individual mass, size and position of each body; the same we know to have occurred in the case of the earth's figure, being at first ellipsoidal, but now to some extent irregular—or the terrestrial strata of rocks, which were at first continuous, but are now greatly dislocated.

3d. This cause has been and is *the resistance of the ether* filling the heavenly space in which the celestial globes are moving; for the mathematical investigation of the effects of such a resistance agrees perfectly with the phenomena observed, especially in the following particulars:

4th. *The configuration of the solar system* is exactly as such a resistance would modify it; for, admitting a regular law for the primitive distances,[20] we obtain a determination of the *relative age of the planets which increases with the distance from the sun* and is the more regular, the closer we follow the conditions of the problem (as in taking the mass into account);

5th, Even the different *satellites of Jupiter* follow this same law; and

6th, Whilst the *lunar world of Jupiter* appears to be of about the same irregularity as the planetary world,

7th, The *lunar world of Saturn* shows decidedly older (i. e. less regular) features, thus confirming the previously obtained result as to its age; it is even made evident that

8th. This *lunar world of Saturn* in its present configuration remarkably resembles the configuration of the whole planetary world at the end of the *fourth age* (i. e. according to our estimate, after 40,000,000,000 years); again,

9th, The *lunar world of Uranus* corresponds in its configuration to a yet higher age, thus again corroborating the determination of its age.

10th. The *closeness of the orbits*, and even the distance of the first secondary from its primary are according to the same law of resistance.

11th. This age, as determined by resistance and confirmed by the observed configuration, exactly corresponds to that ascribed to the several bodies in the theory of Kant and Laplace;

12th. The variation of the density of the planets is in complete harmony with this theory and the laws of resistance—*the mini-*

[20] We tried about thirty different laws only agreeing in the successive enlargement of the mutual distances; all gave substantially the same variation of the age.

mum density observed in Saturn being a highly important confirmation of both theories;

13th. The *law of rotation* affords a most interesting and valuable proof for the theory of Kant and Laplace, instead of being at variance therewith; for the theory, if analytically expounded, demands just the very transition in direction and just the same position of axis, as observed in the rotary motions of the planets, Uranus forming the transition.

14th. If the laws of attraction are not fully identical with those of repulsion, *the created matter would already virtually contain the tangential force* upon which the duration of the whole world principally depends. This is simply an instance of "throwing the first cause further back," since the translatory movement no longer needs to be considered as a *direct* action of the Creator, but as a *design*, embodied and effected through some *previous direct act.*

15th. It is probable that *the force lost in resistance is converted into magnetism.*

I know that some, like Brewster, will object to these and similar efforts; yet we always feel the more deeply convinced of the glory and power and wisdom of the Creator and governor of the universe, the more we perceive how simple His means, how grand His design, and how multiform His effects; unlike ourselves, the Creator needs no tools, no constant effort for producing His ends; His almighty "*fiat*" created the universe, and His right hand sustains it ever since.

Do we not see a natural development even in man, the most highly endowed creature we know—how, then, can it be heresy to ascribe a natural development (i. e. conformable to the laws of nature, which are the unalterable edicts or thoughts of nature's lawgiver, God) to the simple, dead heavenly globes, which only are the footstool whereon the higher organized creation has been placed? Rather we think if science ever approached heresy it did so in proclaiming the stability, i. e. the eternity, of the solar system to have been mathematically demonstrated!

No—death, indisputably, death pervades all nature; not only man, and with him the organized beings, both animals and plants, die—even the whole planetary system, shows already the wrinkles of age on its once beautiful and harmonious face from which the sun yet shines forth as the eye of the world—even this organized system will die, its members will fall into the sun; but since we have abundant reason to believe the whole solar world with all its wonders to be in the great All only a little drop in the deep—how great is the *Father of this All*, if the death of such a stupendous World is to Him what the last breath of a coral is to us!

ART. V.—*Researches on the Platinum metals;* by WOLCOTT GIBBS, M.D.

(Continued from vol. xxxiv, p. 342, Nov., 1862.)

THE mass of mixed double chlorids, after the volatilization of the osmium and the separation of the iron and other impurities by washing with a concentrated and cold solution of chlorid of potassium or ammonium, is to be rubbed to fine powder, boiling water added, and the iridium reduced by a dilute solution of nitrite of soda, care being taken not to use more of this salt than is sufficient to convert the iridium salt, $IrCl_2KCl$, into $Ir_2Cl_3 3KCl$, and to keep the solution neutral with carbonate of soda. Almost the whole of the chlorplatinate of potassium remains undissolved, while the iridium, rhodium, and ruthenium soluble salts remain in solution. The liquid is to be allowed to cool, filtered, the remaining mass washed with cold water until only the chlorplatinate of potassium remains, and the washings filtered and added to the main solution. If the washings have been carefully performed with small successive quantities of water, very little platinum is dissolved, and the olive-green solution contains chiefly $Ir_2Cl_3 3KCl$, $Rh_2Cl_3 3KCl$, $Ru_2Cl_3 2KCl$, and $RuCl_2KCl$ with insignificant quantities of $PtCl_2KCl$.

A solution of chlorid of luteocobalt, $6NH_3 . Co_2Cl_3$, is now to be cautiously added as long as a precipitate is produced: a copious pale buff precipitate is thrown down which settles easily, leaving a yellow or orange-yellow solution containing the luteocobalt salt in small excess. The precipitate is to be washed by decantation, then thrown upon a filter and thoroughly washed with boiling water and afterward with boiling dilute chlorhydric acid. The filtrate and washings are to be evaporated together on a water-bath to dryness. They contain the whole of the ruthenium and platinum present in the original solution. The mass upon the filter, which has a pale buff color, consists of the two insoluble double salts,

$$6NH_3 . Co_2Cl_3 + Ir_2Cl_3, \text{ and } 6NH_3 . Co_2Cl_3 + Rh_2Cl_3,$$

and is perfectly free from ruthenium and platinum.

This process is based upon the fact that the iridium and rhodium double salts above mentioned are almost absolutely insoluble in boiling water and in boiling dilute chlorhydric acid, while the ruthenium and platinum salts, which have respectively the formulas

$$6NH_3 . Co_2Cl_3 + 3RuCl_2, \text{ and } 6NH_3 . Co_2Cl_3 + 3PtCl_2,$$

are easily soluble.

Palladium also forms with chlorid of luteocobalt a double salt which is easily soluble in dilute chlorhydric acid, and which

crystallizes from the solution, on cooling, in beautiful orange-yellow granular crystals. The formula of this salt is $6NH_3 . Co_2 Cl_3 + 3PdCl$. Any traces of palladium which may have been present in the original mass of double chlorids will therefore be found with the ruthenium and platinum salts. When the mixed chlorids have been thoroughly washed, palladium is never present. The sesquichlorid of ruthenium gives no precipitate with solutions of chlorid of luteocobalt, and appears not to form a double salt with the chlorid of this radical, possibly in consequence of the *tri*acid character of luteocobalt and the *bi*basic character of the sesquichlorid of ruthenium, the potassium double salt being $Ru_2Cl_3 + 2KCl$. All the sesquichlorid of ruthenium present in the mass of mixed chlorids in combination with chlorid of potassium will therefore be found in the filtrate from the insoluble iridium and rhodium double salts.

The mass of double salts of iridium and rhodium with luteocobalt, after complete washing, is to be brought into a flask and boiled with a strong solution of caustic potash until ammonia ceases to be given off. With a concentrated solution this may be effected in a short time. On addition of an excess of chlorhydric acid the black powder readily dissolves, giving a solution which contains the double chlorids of iridium and potassium and rhodium and potassium, $Ir_2Cl_3 3KCl$, and $Rh_2Cl_3 3KCl$, together with chlorid of cobalt. The solution is to be evaporated to dryness and the chlorid of cobalt dissolved out by boiling with absolute alcohol. The iridium and rhodium are then to be separated by nitrite of soda and sulphid of sodium or ammonium in the manner already pointed out. The sulphid of rhodium after washing and continued ignition gives pure metallic rhodium.

The filtrate from the iridium and rhodium salts contains a comparatively large quantity of ruthenium in the form of $Ru_2 Cl_3 2KCl$ and $RuCl_2 KCl$, together with a trace of the ruthenium and platinum double salts, $6NH_3 . Co_2Cl_3 + 3RuCl_2$ and $6NH_3 . Co_2Cl_3 + 3PtCl_2$. The solution is to be evaporated nearly to dryness, boiled with a strong solution of caustic potash, and then treated with an excess of chlorhydric acid, which gives the double chlorids $RuCl_2 KCl$, $PtCl_2 KCl$ and $Ru_2Cl_3 2KCl$, together with an excess of chlorid of potassium and a little chlorid of cobalt. This last may easily be removed by alcohol after evaporating the mixed chlorids to dryness. Platinum and ruthenium may then be separated by boiling with nitrite of potash, evaporating to dryness, boiling with dilute chlorhydric acid so as to convert the whole of the ruthenium into $RuCl_2 KCl$, neutralizing with carbonate of potash, again boiling with nitrite of potash, evaporating to dryness and dissolving out the *double nitrite* of ruthenium and potash by absolute alcohol.

The nitrite of ruthenium and potash may then be treated in the manner already described and the ruthenium brought into the form of the double salt of mercury and ruthendiamin, from which the pure metal is easily obtained. This method of separating the platinum metals gives excellent results, but is not free from objection. In the first place it will be remarked that it does not dispense with the employment of the alkaline nitrites, although to some extent it facilitates their use. But the chief objection is found in the necessity of employing very large quantities of chlorid of luteocobalt, a salt which is not to be had in commerce and which must therefore be specially prepared for the occasion.

This difficulty may be in a great measure avoided by employing the chlorid of luteocobalt chiefly as an agent for the separation of rhodium from platinum and ruthenium, which may be accomplished in the following manner. The mass of mixed double chlorids, after the removal of the iron, &c., by washing, is to be rubbed to a fine powder in an unglazed porcelain mortar and then washed with cold water in small portions at a time until the washings give no sensible reaction for ruthenium, when tested in the manner already described with nitrite of potash and colorless sulphid of ammonium. The washings contain all the ruthenium as $RuCl_2 KCl$ and $Ru_2Cl_3 2KCl$, and all the rhodium as $Rh_2Cl_3 3KCl$, together with a not inconsiderable portion of iridium as $IrCl_2 KCl$, and a much smaller quantity of platinum as $PtCl_2 KCl$. The iridium in this solution is to be reduced to sesquichlorid by the addition of a dilute solution of nitrite of soda with a little carbonate of soda to keep the solution as nearly neutral as possible. A solution of chlorid of luteocobalt is then to be added as long as a precipitate is produced, when the whole is to be filtered and the precipitate thoroughly washed, first with boiling water and afterward with water containing a little chlorhydric acid. The precipitate on the filter consists chiefly of the rhodium salt $6NH_3 . Co_2Cl_3 + Rh_2Cl_3$, with a smaller proportion of the corresponding iridium salt. The mixed rhodium and iridium salts are then to be boiled with a solution of caustic potash as long as ammonia is evolved, treated with excess of chlorhydric acid, evaporated to dryness, the chlorid of cobalt dissolved out by alcohol, and the iridium and rhodium separated by nitrite of soda and sulphid of ammonium in the manner already pointed out.

The filtrate from the insoluble rhodium and iridium salts contains the ruthenium as $RuCl_2 KCl$ and $Ru_2Cl_3 2KCl$, together usually with a small quantity of the double salt $6NH_3 . Co_2Cl_3 + 3RuCl_2$ and of $PtCl_2 KCl$. The platinum and ruthenium are then to be separated with nitrite of potash and alcohol by the process already described. This method of employing the

chlorid of luteocobalt is extremely convenient when it is desired to obtain pure ruthenium or rhodium at once from the osmium-iridium.

The presence of a portion of the ruthenium in the form of Ru_2Cl_3 2KCl in no wise modifies the application of the above process, because this salt gives no double decomposition with a solution of chlorid of luteocobalt. As the nitrite of soda employed to reduce the $IrCl_2$ to Ir_2Cl_3 may exercise a reducing action on the Ru_2Cl_3, it will be found advantageous after washing out the $RuCl_2$ KCl and Ru_2Cl_3 2KCl, to convert the Ru_2Cl_3 2KCl entirely into $RuCl_2$ KCl. This may easily be accomplished by adding a solution of caustic potash in excess and then passing a current of chlorine gas into the liquid until the odor of hyper-ruthenic acid is observed. By adding nitric acid in excess so as to dissolve the black precipitate at first produced, and then evaporating to dryness with an excess of chlorhydric acid, the whole of the ruthenium will be brought into the form of $RuCl_2$ KCl.

When a solution of chlorid of luteocobalt is added to one containing bichlorid of iridium, an insoluble buff-colored precipitate is thrown down, consisting of a salt which has the formula $6NH_3 . Co_2Cl_3 + 3IrCl_2$. When this salt is digested or boiled with an alkaline nitrite, the bichlorid of iridium is reduced to sesquichlorid, and the salt $6NH_3 . Co_2Cl_3 + Ir_2Cl_3$ is formed, well characterized by its extreme insolubility. In the presence of a large excess of platinum in the form of $PtCl_2$KCl, it is very difficult to reduce iridium completely from bichlorid to sesquichlorid, and even in the presence of an alkaline nitrite the chlorplatinate of potassium, after repeated crystallization, obstinately retains a reddish or deep orange tint arising from traces of the corresponding iridium salt. The presence of the smallest trace of iridium may be easily detected in the platinum salt by dissolving the whole in boiling water and adding a solution of chlorplatinate of luteocobalt, $6NH_3 . Co_2Cl_3 + 3PtCl_2$, which precipitates only its equivalent of the corresponding iridium salt. The precipitate is to be filtered off and digested with a hot solution of nitrite of soda or potash, a small excess of a solution of chlorid of luteocobalt added, and the double chlorid $6NH_3 . Co_2Cl_3 + Ir_2Cl_3$ thoroughly washed. This process affords a perfectly satisfactory method of separating iridium quantitatively from platinum, and for analytical purposes is more convenient than the separation by an alkaline nitrite and sulphid already described. The quantitative separation of iridium from ruthenium and palladium is also readily effected by the chlorid of luteocobalt, as well as the separation of rhodium from platinum, ruthenium and palladium. I shall return to this subject in treating of the metals of this group separately and will then point out

another method of using the chlorid of luteocobalt, which is also deserving of attention.

The separation of the metals contained in the mass of sulphids precipitated in the separation of iridium from rhodium, ruthenium and platinum, by the method already pointed out, may be very conveniently effected in the following manner. The mixed sulphids are to be dried, separated from the filter and intimately mixed in a mortar with an equal weight of a mixture of equal parts of carbonate and nitrate of baryta. The filter is to be burned and the ash mixed with the sulphids and baryta salts. The mixture is then to be ignited in a porcelain or earthen crucible for an hour at a full red heat, and the mass, which does not fuse, treated with strong chlorhydric acid, which dissolves the oxyds of rhodium, ruthenium and platinum completely, leaving only sulphate of baryta. The baryta is then to be precipitated by sulphuric acid, an excess of which must be carefully avoided, and then a solution of chlorid of luteocobalt added as long as a precipitate is formed. The double chlorid of rhodium and luteocobalt may then be filtered off and thoroughly washed with boiling water acidulated with chlorhydric acid. By igniting this salt and dissolving the chlorid of cobalt out from the mass, pure metallic rhodium remains. The platinum and ruthenium in the filtrate may then be separated by means of nitrite of potash and alcohol in the manner already described.

This method of treating the sulphids requires only a small quantity of chlorid of luteocobalt, is extremely easy of application and is much shorter than the first method which I have described. Taken in connection with the process for separating iridium by means of nitrite of soda and sulphid of sodium, it furnishes an easy and complete solution of the problem of the qualitative or quantitative separation of the metals of this group, osmium only being determined by the loss.

Cambridge, Nov. 10th, 1863.

(To be continued.)

ART. VI.—*Tubularia Not Parthenogenous;* by Prof. HENRY JAMES CLARK, of Harvard University, Cambridge, Mass.

IT is with no small degree of pleasure that I announce the discovery of the *eggs* of the Tubularians. During the middle of October I had in my aquarium the three most common species, of this group, on our shores, viz: Tubularia indivisa Lin. (T. Couthouyi Ag.) Thamnocnidia coronata Ag. (Tubularia coronata Abild., Thamnocnidia spectabilis Ag.) Parypha calamaris? (P. crocea Ag., Tubularia calamaris Van Ben.?). In each of these I have traced the development of the *egg*, from its inception to

the time of its escape, as a hydroid form from the medusoid genital. I do not wonder that the egg has eluded the observation of naturalists thus far, for so faint are its outlines that it might be put down as one of the tests of a first class objective. Although I had obtained glimpses of it with a Tolles' $\frac{1}{8}$ inch objective, yet it was not until I applied a $\frac{1}{4}$ inch objective, of the same optician, that I gained a clear and unmistakable view of this long sought body. Thus we are relieved of what once seemed to be the anomaly of a male, on the one hand, producing a perfect fecundating material, and, on the other hand, a female producing young without a corresponding fertilizable egg.

In order to make the mode of development of the egg fully comprehensible, I must prelude the description by an account of some other discoveries which I have made in regard to the muscular system of Hydroids. It has long been a matter of speculation among physiologists and zoölogists as to what is the basis of contraction in these animals; and some indeed have given themselves up to the idea of a contraction of the individual cells of the walls, imagining themselves to be warranted in this belief by the supposed example of the so-called unicellular Infusoria. Not discovering the true muscular layer, they have mistaken the effect for the cause; seeing the cells of the walls of a Hydroid diminishing during the contraction, and enlarging during the expansion of the animal, they have supposed that the individual cells were the instruments which effected their own changes; whereas they were only the subjects of a power which reigned among them. As long ago as 1843, Quatrefages (Ann. Sc. Nat., vol. 20,) got a glimpse of the muscular system of one of the Hydroids, Hydractinia (Synhydra Quatrf.); but his story is so mingled with what is, without much doubt, incorrect, that it would be impossible to generalize from his observations.

I made my first satisfactory determination of the position of the muscular system of Hydroids in Coryne, ("C. mirabilis" Ag.) more than a year and a half ago. The discovery is noted thus in my journal, "March 14, 1862. Between the outer and inner walls (of the hydraform Coryne) of the body and tentacles, there is a layer of longitudinal fibrillated *muscular bands.*—The cells of the core of the tentacles are arranged about an imaginary axis in three ranks, that is, the breadth of three cells occupies the whole circumference of the tentacles; and the so-called axial column is composed of the interstitial granules at the inner ends of the cells."—In the following month my journal runs thus. "April 13, 1862. Walked to Boston and collected Tiaropsis ("T. diademata" Ag.), Bougainvillia ("B. superciliaris" Ag.), and Sarsia, (Coryne mirabilis" Ag.). The muscular system, of Tiaropsis, Bougainvillia, and Sarsia, is a layer of circular and a layer of longitudinal

fibrillæ[1] lying between and behind the innermost and middle walls of the disc." Thus I had verified the existence of a muscular system in both the Hydroid and its medusogenitalia. I would also mention in passing that in the hydraform Scyphostoma of Aurelia aurita ("A. flavidula" Ag.), which I had raised from eggs and kept in my aquarium for eighteen months, I detected, last January, a similar, longitudinally fibrillated layer of muscles, between the outer and inner walls of the stem, disc, and tentacles. In the proboscis, disc and base of the tentacles, and in the four equidistant columns, or pilasters, which project into the digestive cavity, this muscular layer is separated from the inner wall by a *gelatiniform layer* of varying thickness. In the four pilasters the gelatiniform layer is a solid core which thins out suddenly, at the top of the stem, to a slender cord, and in this form it continues to the bottom of the stem of the Scyphostoma. I have already published a detailed account of the muscular system of the adult medusoid form of this species in Agassiz's Contributions to the Natural History of the United States, vol. iv, p. 61. I would also refer to the May number of this Journal, page 347, note 5, for a minute account of the gelatiniform layer of this medusa. In regard to the development of the muscular system of Aurelia, I would so far modify my opinion as to say that the fibrillæ are developed from a substratum of interstitially originating formative cells, which are metamorphosed, after the well known method, into contractile threads. I hope I may be pardoned for this divergence from the base upon which I began, because I hope thereby to disclose the more general prevalence of this myological feature in the morphology of Acalephæ.

During my studies upon the development of the eggs of the

[1] The *presence* of a muscular system in Hydro-Medusæ was long ago detected by Wagner, Sars and others; but they gave no details of its structure or position. Later, Huxley described the system in Siphonophoræ, as being *in the outer wall.* We owe to Allman the credit of having first pointed out, in the hydraform, the nature and true position of the muscular system. He says, (Anat. and Physiol. of Cordylophora, Phil. Trans. 1853, p. 372), "It consists of numerous longitudinal fibres, which are in close contact with the inner surface of the ectoderm." "Similar fibres may be witnessed in Coryne, Syncoryne, and other marine Tubulariadæ," &c. The most elaborate attempt upon this subject is that of Agassiz. His description of the muscular system of Hippocrene, Sarsia and Tiaropsis, in his monograph, on the Acalephæ of North America, Mem. Am. Acad., 1849, and repeated, in part, in his "Contributions to the Natural History of the United States," iv, 213, is a representation of an effect for a cause; as he has uniformly described the *wrinkles* of the walls, produced by contraction, as *muscular fibres;* and everywhere the cells of either the innermost or middle wall are described as "*contractile cells*" of the muscular layer. The truth is, the muscular layer is composed of *fibrillæ*, which, I have every reason to believe, are developed by a direct arrangement from the insterstitial blastema, simply through the intervention of the *formative-cell process,* and not by a disintegrative metamorphosis of fully organized cells. In the section on Coryne in Agassiz's "Contributions," there is such a startling incongruity between the description of the structure of the last stages of the young medusoid, and what follows upon the anatomy of the adult form, that one is forced to believe that the two parts of the investigation were made by different observers. Certainly *no diversity of age could produce this.*

Tubularians I have found it impossible to understand the mode of origin of the ovigerous layer without taking into account the development and varying position of the muscular layer. In the hydroids of these three Tubularians, there intervenes an excessively thin, longitudinally fibrillated muscular layer between the outer and inner walls of the stem, disc, tentacles, and branching stems of the genitalia; and whenever the latter pullulate to form a genital sac, a medusoid, all the cellular and muscular elements enter into the operation, and thus there arises at first a highly contractile, triple walled hernia, the outer wall of which consists of a single stratum of broad cells, each containing a large nucleus; the middle wall, or stratum, forms the muscular layer; and the innermost wall is made up of a single layer of very large prismatic cells. This is the first stage of medusoid development. Hardly, however, has the bud declared itself before the ovigerous layer begins to develop. This is done in a very simple manner; at the end of the bud, the inner wall, and with it the muscular layer, recede from the outer wall, and leave between them a space which is occupied by a distinct, peculiarly colored substance, which is no less than the incipient ovigerous layer. Cotemporary with the origin of this layer the eggs appear; and in fact they may be said to form nine-tenths of the bulk of this stratum, the remainder constituting the intercellular blastema, such as I think is the original basis of all cell development. The eggs, although they eventually become very numerous, are at first only very few in number, perhaps five or six, and compare in size with the cells of the outer wall of the bud. The very distinct Purkinjean vesicle occupies about one-third of the diameter of the ovum. As the space between the walls of the bud increases, it gradually assumes a spheroidal form, and as it is constantly filled by the ovigerous layer, the latter also becomes globular. Surrounding this space we have on one side the outer wall at the end of the bud, and on the other side, the inner wall, lined by the muscular layer, assuming a cup-shaped form. Gradually and during the process of growth the edge of the cup becomes narrowed, and by degrees closes over the intervening space occupied by the ovigerous layer, and shuts the latter off from the outer wall. By this process that part of the muscular layer which lines the cup and directly embraces the ovigerous layer is cut off from that part of its continuation which lies beneath the outer wall. In this condition the end of the medusoid is constructed thus: proceeding from without inwardly, we have an outer wall, an outer muscular layer, an inner cellular layer formed by the closing over of the edge of the cup, an inner muscular layer surrounding a fifth stratum which is the ovigerous layer.

Only one step more is now required to perfect the morphological plan of development of this organ, and that is brought

bout by a simple hollowing out of the ovigerous stratum, so that, nstead of remaining a solid mass, it becomes as it were a lining o the muscular layer, which embraces it. Thus in an end view of the bud we would have a hollow sphere made up of five concentric layers, succeeding each other as enumerated above. This s essentially the typical form of the meduso-genitalium of the Tubularians; for whatever changes occur in the later days of growth, no new morphological features are instituted.

The development of the radiating and circular tubes in Tubularia is merely a hollowing out of channels in the middle wall of the bud; and the formation of a proboscis in all three of the species of Tubularians is simply through a development of a protuberance, from the bottom of the cup, in such a manner that a part of the ovigerous layer, or innermost wall of the meduso-genital, becomes the outer wall of the proboscis; the subjacent muscular layer, which originally embraced it, becomes apparently inverted in its relations, and in its turn lies beneath this wall; and lastly, what was formerly the outer wall at the bottom of the cup becomes the inner wall of the proboscis.

The only difference, if it can be called a difference, between this meduso-genital and the more highly developed free forms of such as Hybocodon, Corymorpha, Bougainvillia, Lizzia and Coryne, is that the latter do not develop eggs in their ovigerous layer, or as it has been called in them, the outer wall of the proboscis and the innermost wall of the bell, until a much later period.[1] The mode of development of all the walls is alike in the

[1] *On the walls of the most highly developed medusoid.*—The immense gelatiniform mass which constitutes such a large proportion of the bell of these free forms —or even of some of those which remain fixed at the latter end of the breeding season, as in "Coryne mirabilis,"—is merely an extraordinary increase of the interstitial blastema of the two adjoining, outer and middle walls, between which it develops as these recede from each other. In the younger stages of the medusoid, the gelatiniform substance exhibits an irregular fibroid structure, with a few multicaudate cells, and granules here and there; but in the adult period it is exceedingly difficult to detect any fibrillization. This is always the last layer formed in the process of development, and with it we have the highest kind of meduso-genitalia. In this condition the bell of a medusoid, for instance "Coryne (Sarsia) mirabilis," is constituted thus: 1st, there is the outer wall, *ectophragma;* 2d, the gelatiniform layer, *chondrophys;* 3d, the outer muscular stratum, *ectomyoplax,* which presses closely upon the middle, 4th, wall, *mesophragma;* 5th, the inner muscular layer, *endomyoplax;* and 6th the innermost wall, *endophragma.* In the proboscis,—*manubrium,* Allman,—we have, 1st, the outer wall, *ectophragma manubriale;* 2d, the muscular layer, *myoplax manubrialis;* and 3d the inner wall *endophragma manubriale.* In the velum all the layers, except the chondrophys, exist, and follow each other as in the bell proper. In the tentacles there are but three strata, viz. 1st, the ectophragma, 2d, the myoplax, which is continuous with the ectomyoplax of the bell, and 3d, the endophragma, in continuity with the mesophragma of the bell. Now in the fully-formed meduso-genital of the above mentioned Tubularians, T. indivisa, &c., only the chondrophys is wanting. The terms *ectoderm* and *endoderm* I gladly adopt for, yet would restrict to, the outer and inner walls of the cœnosarc of the hydraform; but as it would seem to be a misapplication of terms to call the "middle wall," of the meduso-genital or gonophore, a *derm,* I apply to it the name *mesophragma,* i. e. *median wall or partition,* and to the outer and inner walls of the *same, to carry out the idea, the terms ectophragma* and *endophragma.*

former and the latter; *there is but one type of development in the medusoids of all the Hydroids.* This is what my observations within the past two years have led me to believe. The further development of the young of the Tubularians proceeds in an unequal degree for the different individuals, some of them grow much more rapidly than others, and finally, becoming separated from their matrix, move freely in the cavity of the genital organ, until their tentacles are developed so as to present *the same one-sided cylindrico-claviform outlines as the parent,* and then they escape into the open sea. Thus they succeed each other until the ovigerous layer is totally bereft of all its progeny, and nothing but a faintly granular blastema is left to represent the outer wall of the proboscis, and its continuation the innermost wall of the bell. I would add finally, that in the males of these Tubularians, not even excepting Parypha, the meduso-genitals are identical in form, structure, and development with those of the females.

ART. VII.—*Contributions from the Sheffield Laboratory of Yale College*—No. VI.—*On Tephroite,* by GEO. J. BRUSH.

TEPHROITE was first recognized as a distinct mineral species, by Thomson, who described it under the name "*silicate of manganese.*"[1] The specimens examined by Thompson were from Franklin, New Jersey, and were sent to him by Dr. Torrey, who, in a note to Thomson's article, reports the mineral as "not scarce at Franklin," and, as "generally associated with red zinc ore and massive franklinite." Subsequently, a mineral from Sparta, of like chemical composition and physical characters, was described by Breithaupt, and named *tephroite.*[2]

Of late years this species appears to have been confounded with the troostite varieties of willemite, and to have been almost entirely overlooked by collectors. It so much resembles the massive willemite, that I question whether it has been recognized by many mineralogists. In order to clear up doubts in my own mind, in regard to it, I obtained, through the kindness of Professor Breithaupt, a fragment of the original specimen in the collection of the Royal Mining Academy in Freiberg, and with this I have been enabled to identify the species at Stirling,[3] where it occurs in considerable abundance. It has a distinct cleavage in two directions, giving nearly, or quite, a right angle at the intersection; this permits its being readily distinguished from the varieties of willemite, which it so much resembles in color and

[1] Annals Lyc. Nat. Hist., New York, vol. iii, (1828) p. 26.
[2] *Breithaupt,* Charakteristik des Mineral System's, 3d ed., pp. 211, 329.
[3] *Stirling Hill* is in the town of Sparta.

ustre. The specimen received from Professor Breithaupt had he following physical and chemical characters—Color, dark-ash o smoky-gray. Lustre, vitreous to greasy. Hardness, 6. Spe-ific gravity, 4·10 (Breit.). It was associated with franklinite nd zincite; small specks of the latter species were so intimately nixed with the tephroite that great care was required to obtain he mineral pure for analysis. The zincite seemed to be dis-ributed as a thin scale, in the direction of most perfect cleavage, n some places forming an almost continuous layer. Cleavage, listinct in two directions, giving nearly a right angle. Des Cloizeaux has shown, from the examination of crystals in his possession, which have been identified with tephroite by the analyses of Deville and Damour, that the form of this mineral is trimetric and isomorphous with chrysolite.[4] Before these results were known in this country, I sent a small fragment of the original mineral, received from Breithaupt, to Professor Des Cloizeaux with the request that he would examine its optical characters. In answer to my request, he has kindly communicated to me the following observations.—"The fragment of *tephroite* which you sent is flattened on two faces, which appear to be natural.[5] These show fine striæ parallel to each other and to a cleavage plane, which seems to me to be perpendicular to the faces, for approximative measurements gave 89° to 89° 30′ on one side, and 91° to 91° 30′ on the other; the cleavage is brilliant, but the larger faces are dull and reflect poorly.[6] After several trials, I succeeded in obtaining two very small plates, which, observed under oil with a polarizing microscope, showed a beautiful system of rings, perfectly symmetrical around a negative bisectrix, and set in a plane parallel to that of easy cleavage. The angle between the optical axes is considerable, and under oil I obtained:

2H=84° 19′ Red rays, hence 2 E=159° 1′
82° 59′ Blue rays, hence 2 E=156′ 58′ in air.

The indices of refraction of the oil employed were 1·465 for the red rays, and 1·479 for the blue rays. As my small plates were not cut absolutely normal to the bisectrix, these measurements are sufficiently near those published in my paper to enable us to indentify the species, especially as the position of the plane of the axes, and the character of the dispersion is the same in both cases."[7]

These important observations, in connection with the memoir by Professor Des Cloizeaux, before alluded to, demonstrate conclusively that the optical and crystallographic characters of the

[4] Annales des Mines, 5th Series, vol. ii, p. 339.

[5] These faces were cleavage planes.—(G. J. B.)

[6] This want of brilliancy on the broad cleavage plane was unquestionably due to the film of zincite before alluded to.—(G. J. B.)

[7] From a letter *from Professor Des* Cloizeaux, dated Paris, Feb. 18th, 1868.

original tephroite are similar to those of chrysolite, and that this isomorphism is further sustained by the chemical composition of the minerals, both being represented by the general formula $\dot{R}^3\ddot{Si}$.

Before the blowpipe, tephroite fuses easily to a black mass; fusibility $=3{\cdot}5$ on v. Kobell's scale. With the fluxes, gives reactions for silica, manganese, and iron. On charcoal, most specimens give traces of zinc, due to the mechanical mixture with zincite. Heated in the closed tube, it gave traces of moisture. Chlorhydric acid dissolves the mineral without an evolution of chlorine, and on heating the solution a perfect jelly is formed. In the quantitative examination, great care was taken to make accurate separations of the different bases. The silica was determined in the usual manner—the iron was separated as basic acetate—the manganese was oxydized and precipitated by bromine, this oxyd was redissolved, precipitated as carbonate, and weighed as proto-sesquioxyd—the zinc was precipitated as sulphid, and this redissolved and again precipitated as carbonate—the lime was separated as oxalate, care being taken to redissolve the precipitate to free it entirely from magnesia. Composition:

		Oxygen.	
Silica,	30·19	16·10	16·10
Manganous oxyd,	65·59	14·78	
Ferrous oxyd,	1·09	0·24	
Magnesia,	1·38	0·55	15·92
Lime,	1·04	0·30	
Zinc oxyd,	0·27	0·05	
Ignition,	0·37		
	99·93		

The small amount of oxyd of zinc was unquestionably due to zincite, and deducting this from the oxygen of the bases, the ratio is 16·10 to 15·87 or 1 : 1, giving the formula $\dot{R}^3\ddot{Si}$. The analysis hence shows tephroite to be an almost pure *manganesian chrysolite.* These results agree essentially with those obtained by Rammelsberg and Thomson, although I find a little magnesia and lime which is not indicated in their analyses.

At Stirling, I found two varieties of a mineral, which, in cleavage and general physical characters, resembled Breithaupt's tephroite. One of the varieties had a slightly reddish-brown color, while the other was more distinctly reddish-brown, and on the cleavage surfaces almost flesh-red. Both specimens were less fusible than the original tephroite, the brown variety fusing at about 4, while the reddish variety had a fusibility nearly equal to 5 of v. Kobell's scale. In all other physical characters these two substances appear to be identical with tephroite. They very much resemble feldspar, and were it not for their high specific *gravity,* most mineralogists would, on a mere inspection, deter-

nine them to be members of the feldspar group. The mineral hat I found at Stirling exhibited a beautiful and vivid green phosphorescence when struck with a hammer in a darkened room. The broad cleavage surface is striated with fine parallel lines. Analyses made by Messrs. Peter Collier and Arnold Hague under my direction in this Laboratory gave the following composition. No. 1, brown variety, analyzed by P. Collier. No. 2, red variety, analyzed by A. Hague.

	1.	Oxygen.		2.	Oxygen.	
Silica,	30·55	16·29		31·73	16·92	
Manganous oxyd,	52·32	11·79		47·62	10·73	
Ferrous oxyd,	1·52	0·34		0·23	0·05	
Magnesia,	7·73	3·09	16·84	14·03	5·61	17·48
Lime,	1·60	0·45		0·54	0·15	
Zinc oxyd,	5·93	1·17		4·77	0·94	
Ignition,	0·28			0·35		
	99·93	G.=2·97		99·27	G.=2·87	

Both minerals were associated with zincite, disseminated in the same manner as in the original tephroite, and the oxyd of zinc given in the analyses is undoubtedly due to this impurity. Des Cloizeaux has also published analyses of two specimens of this mineral, in both of which zincite was present as a mechanical impurity. These analyses, made by Deville[8] and Damour,[9] gave the following results:

$\dddot{Si}$	$\dot{M}n$	$\dot{F}e$	$\dot{M}g$	$\dot{C}a$	$\dot{Z}n$	Ign.	
28·37	59·31	2·16	2·16	0·39	7·58	——= 99·97	Deville.
29·95	36·43	1·96	18·60	——	11·61	1·71=100·26	Damour.

Excluding the oxyd of zinc in my analysis, and in those by Collier, Hague, Deville and Damour, we have—

	$\dddot{Si}$	$\dot{M}n$	$\dot{F}e$	$\dot{M}g$	$\dot{C}a$	Ign.	
1.	30·27	65·77	1·09	1·39	1·04	0·37= 99·93	Brush.
Oxygen,	16·14	14·82	0·24	0·56	0·30		
2.	30·70	64·17	2·34	2·34	0·42	——= 99·97	Deville.
Oxygen,	16·37	14·46	0·52	0·94	0·12		
3.	32·48	55·62	1·61	8·22	1·70	0·30= 99·93	Collier.
Oxygen,	17·32	12·53	0·36	3·29	0·48		
4.	33·33	50·02	0·24	14·74	0·57	0·37= 99·27	Hague.
Oxygen,	17·78	11·27	0·05	5·90	0·16		
5.	33·88	41·20	2·22	21·03	——	1·93=100·26	Damour.
Oxygen,	17·80	9·28	0·49	8·41			

The ratio of the oxygen of the silica to that of the bases in No. 1, is 16·14 : 15·92. No. 2, 16·37 : 16·04. No. 3, 17·32 : 16·66. No. 4, 17·78 : 17·38. No. 5, 17·80 : 18·18; in each, almost exactly 1 : 1, giving the formula $(\dot{M}n, \dot{M}g)^3\dddot{Si}$, with only a small portion of the manganese and magnesia replaced by iron and lime.

In Damour's analysis the magnesia, manganese and silica have the oxygen ratio 1 : 1 : 2 corresponding with the formula $\dot{M}g^3\dddot{Si}+\dot{M}n^3\dddot{Si}$ or $(\frac{1}{2}\dot{M}g+\frac{1}{2}\dot{M}n)^3\dddot{Si}$, while in the variety analyzed by

[8] Des Cloizeaux, Manuel de Mineralogie, i, 38. [9] Ann. des Mines, *loc. cit.*

Hague, the ratio is nearly 1 : 2 : 3, giving the formula $\dot{Mg}^3\ddot{Si}+2\dot{Mn}^3\ddot{Si}$ or $(\frac{1}{3}\dot{Mg}+\frac{2}{3}\dot{Mn})^3\ddot{Si}$. The specimens analyzed by Deville and myself, as well as those investigated by Thomson and Rammelsberg, are very nearly pure $\dot{Mn}^3\ddot{Si}$, so that we have here represented three distinct varieties of tephroite, each giving a simple ratio and formula. The replacement of manganese by magnesia, as shown by the above results, is exceedingly interesting, in view of the fact, that both chrysolite and tephroite crystallize in the trimetric form. A further analogy is observed, when the varieties of tephroite are compared with those of chrysolite; for besides the indefinite isomorphous mixtures of magnesia and iron in the various olivines, we have in *boltonite* an example of a magnesian chrysolite, and in *hyalosiderite* an iron magnesian chrysolite, $(\dot{Fe}^3\ddot{Si}+\dot{Mg}^3\ddot{Si})$, while *fayalite* is an almost pure iron-chrysolite. The analyses of tephroite, here given, seem to demonstrate that the varieties thus far examined have no oxyd of zinc in chemical combination, although the mineral is intimately associated with both zincite and willemite.

New Haven, Oct. 1st, 1863.

ART. VIII.—*Crystallographic Examination of the Acid Tartrates of Cæsia and Rubidia;* by JOSIAH P. COOKE, Jr.

1. *Bitartrate of Cæsia*, HO, CsO, $C_8H_4O_{10}$.—This salt forms transparent and colorless crystals belonging to the trimetric system, which may present either a right-handed or a left-handed hemihedrism. The axial relations calculated from the angles Z and Y of the fundamental octahedron are

$$a : b : c = 0{\cdot}661 : 1 : 0{\cdot}694$$

The observed planes were

$+1 = +\frac{1}{2}\,(a : b : c)$	$i\breve{i} = \infty a : b : \infty c$
$-1 = -\frac{1}{2}\,(a : b : c)$	$i\bar{i} = \infty a : \infty b : c$
$-\frac{4}{3}\breve{3} = -\frac{1}{2}(\frac{4}{3}a : b : 3c)$	$1\breve{i} = a : b : \infty c$
$I = \infty a : b : c$	

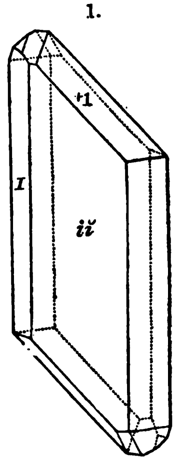
The values obtained for the angles are as follows. Those asterisked were used in calculating the angles given in the second column. As used by Naumann and Dana, X indicates the angle between two planes of the fundamental octahedron over the macrodiagonal edge, Y the angle over the brachydiagonal edge, and Z the angle over the basal edge.

$$X = 103° \qquad Y = 128°\ 50' \qquad Z = 98°\ 30'$$

	Observed.	Calculated.
+1 on +1 over vertex,	81° 30′*	
+1 on +1 over $i\breve{i}$,	51° 10′*	
+1 on −1 over brachy.-edge,	128° 58′	128° 50′
+1 on −1 over macro.-edge,	102° 58′	103°
+1 on I	139° 15′	139° 15′
+1 on $i\breve{i}$	115° 35′	115° 35′
I on I over $i\breve{i}$,	69° 22′	69° 30′
$1\breve{i}$ on $1\breve{i}$ over vertex,		113° 4′

These angles were measured on three different crystals similar to fig. 1, and excepting for the angles between the prismatic planes, the values closely agreed on all. The planes +1 were very perfect and the angles between them agreed to a minute. The planes −1 were not so perfect, but the angles which they formed are accurate as given above within a few minutes. The planes $i\breve{i}$ and $i\bar{i}$ were strongly striated parallel to the vertical axis and the angles made by them with other planes could not be measured with any accuracy when the intersection edge was parallel to the direction of the striation. The same was also true of the angles made by the planes I, under the same circumstances, although no striation was visible and the reflected image was frequently well defined. When, however, the intersection-edge was at right angles or greatly inclined to the striæ, the angles could be measured within a few minutes, and were found to be very constant. The planes $1\breve{i}$ on all the crystals examined were very imperfect and generally only rudimentary.

1.



The crystals of the bitartrate of cæsia cleave with great readiness parallel to the plane $i\bar{i}$, with less readiness, but still easily, parallel to $i\breve{i}$, giving in each case brilliant planes of cleavage at right angles to each other. No evidence of cleavage parallel to the basal section could be detected, the crystals when broken or split in this direction always giving a conchoidal fracture.

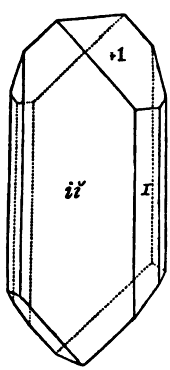
Among the crystals of this salt kindly submitted to our examination by Mr. Allen, two very different types of forms were easily distinguished, which, as we are informed, were the result of wholly different crystallizations. In fig. 1 we have both the positive and negative sphenoids (which form together the fundamental octahedron), the planes of the first being distinguished from those of the last only by being uniformly much more developed and having a greater brilliancy. In another variety of this same type of forms, represented by fig. 2, we have only the

positive sphenoid. Crystals were also observed intermediate between figs. 2 and 1 with the planes of the negative sphenoid in different degrees of development. The crystals of the variety represented by fig. 2 contained a small amount of rubidium; but this isomorphous admixture did not perceptibly alter the angles. We measured on three different crystals

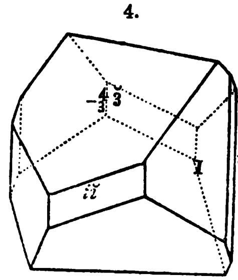
	Observed.	Calculated.
+1 on +1 over vertex,	81° 30′	81° 30′
+1 on +1 over $\breve{i}\breve{i}$,	51° 10′	51° 10′
+1 on I,	139° 15′	139° 15′

These crystals were very perfect and comparatively large, measuring about 7 millimeters long by 5 millimeters wide in the direction of the brachydiagonal. As with the first variety, no accurate measurements could be obtained of the angles between the prismatic planes.

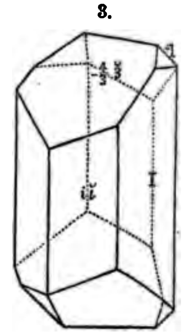
2.



4.



3.



The second type of crystals is represented by the figures 3 and 4. On these forms we have the planes of a left-handed sphenoid, $-\frac{4}{3}\breve{3}$, which are not found on crystals of the first type, and are here so largely developed as to give a very different character to the crystal. Planes of the corresponding positive sphenoid were not discovered, although a large number of crystals were examined. These planes were very dull and rough, even on the smallest crystals, and could not therefore be determined with absolute precision. A reflected image was obtained by attaching to them small plates of mica, and the angles were thus approximatively measured, but the results cannot be relied upon within two or three degrees. The values obtained were

	Measured.	Calculated for $\frac{4}{3}\breve{3}$.
X,	146°	144° 46′
Y,	97½°	101° 52′
Z,	88°	88° 42′

No other probable parameters of these planes would even ap-roximatively satisfy these values. The crystals represented by ig. 3 differ materially from those represented by fig. 4, and were btained by a different crystallization. All of the first have the lanes +1, which could not be detected on those of the last. On hree separate crystals of the form fig. 3, the angle +1 on I meas-red 139° 15′, the same as on the crystals of the first type.

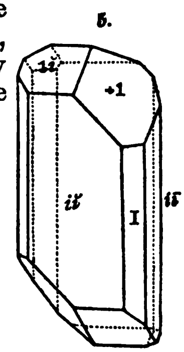
It is evident, then, from this examination that the bitartrate of cæsia forms two different types of crystals, which present respectively a right-handed and left-handed hemihedrism. Either of these hemihedral forms may appear without the other, as in figs. 2 and 4, or they may be united on the same crystal, as in fig. 3. It would be interesting to examine in this connection the optical properties of the salt, but we had not sufficient material for the purpose. The crystals were all proved by spectroscopic examination to be pure bitartrate of cæsia, with the exception of those like fig. 2, which, as already stated, contained a small amount of rubidium. Nothing is known in regard to the conditions of the crystallization, which would to any degree explain the formation of the two different types of forms. The most obvious hypothesis is that they are connected in some way with the two opposite modifications of tartaric acid; but there is no evidence that any other than the ordinary variety of tartaric acid was used in the preparation of the salt.

2. *Bitartrate of Rubidia,* HO, RbO, $C_4H_8O_{10}$.—This salt resembles very closely the last, with which it is isomorphous. The crystals examined were all similar in character, about 5 millimeters long by 2 millimeters wide, and very perfect. They belong to the trimetric system and have the axial relations,

$$a : b : c = 0{\cdot}695 : 1 : 0{\cdot}726$$

The planes observed, with the exception of −1, are represented on fig. 5. They are the same as on the last, with the exception of the negative sphenoid $-\frac{4}{3}\breve{3}$. Of this no trace could be discovered. The planes −1, moreover, were at best very small and generally wholly absent. The angles measured or calculated are as follows:

5.



X=103° 40′ Y=126° 43′ Z=99° 34′

	Measured.	Calculated.
+1 on +1 over vertex,	80° 26′*	
+1 on +1 over ĭĭ,	53° 17′*	
+1 on +1 over īī,	76° 14′	76° 20′
+1 on I,	139° 47′	139° 47′
I on I over ĭĭ,	71° 33′	71° 56′
1ĭ on 1ĭ,		110° 26′

Four different crystals were measured, and the angles on all closely agreed with the exception of the angles between the prismatic planes. To these the same remarks apply as to those of the crystals of the bitartrate of cæsia. As is shown by the figure, the planes $1\bar{i}$ are more largely developed on the crystals of the rubidium than those of the cæsium salt, and in this as well as in the other figures, we have endeavored to preserve as nearly as possible the general habitus of the crystals, as well as the relative dimensions of their planes.

The cleavage of the crystals of the bitartrate of rubidia is in all respects similar to that of the cæsium salt, and the same is true of the crystals formed by an isomorphous mixture of the two substances. Moreover, the planes $\bar{i}\bar{i}$ and $\breve{i}\breve{i}$ are similarly striated on both.

3. *Bitartrate of Potassa.*—We add for the sake of comparison the elements of the crystalline form of the ordinary bitartrate of potassa as determined by Schabus ("Rammelsberg's *Krystallographische Chemie*," page 304). His results, reduced to the system of notation used in this article, are

$$a:b:c=0{\cdot}7372:1:0{\cdot}7115,$$

$$X=100^\circ\ 20', \qquad Y=125^\circ\ 46', \qquad Z=103^\circ\ 38'.$$

For the most part, the same planes occur as on the crystals above described, but the planes of the brachydome are more numerous and more developed. Moreover, the planes $\bar{i}\bar{i}$ instead of being striated vertically, as on these crystals, are striated horizontally, and corresponding to this striation the most perfect cleavage is parallel to the basal section. Cleavages can also be obtained parallel to $\bar{i}\bar{i}$ and $\breve{i}\breve{i}$, but they are less perfect, the last being the most difficult of the three. It will be remembered that the crystals of the bitartrates of cæsia and rubidia could not be cleaved parallel to the horizontal section, and hence, although the dimensions of the form are not widely different, the difference of structure is so great that the potash salt can hardly be regarded as isomorphous with the other two.

The crystals described in this article were prepared, in the Sheffield Laboratory of Yale College, by Mr. O. D. Allen, from the Hebron lepidolite, and we are indebted to his kindness for submitting them to our examination. They have an additional interest from the fact that in his hands they have furnished the means of separating perfectly the two new metals, and of determining with great accuracy the chemical equivalent of cæsium.

Cambridge, November 25th, 1863.

ART. IX.—*Geographical Notices.* No. XIX.

SPEKE AND GRANT'S EXPLORATION OF THE SOURCES OF THE NILE.

THE great event of the year 1862, in geographical exploration, has been the reported discovery of the sources of the Nile by the perseverance and boldness of two English officers, Capt. J. H. Speke, and his associate Capt. J. A. Grant.

A telegraphic despatch from Alexandria to London brought, in May, the brief announcement, "The Nile is settled;" shortly afterward the journal of the travellers was communicated to the Royal Geographical Society, and finally, on the 17th of June last, the explorers themselves arrived at Southampton. A meeting of the Society just mentioned, under whose auspices the expedition had been sent out, was immediately called, and in it Capt. Speke made a statement full of interesting particulars in regard to the route he had followed and the discoveries he had made.

Those of our readers who have followed the progress of African exploration will remember that in 1858, Capt. Speke (then travelling in company with Capt. Burton) discovered the head of a great, fresh-water lake lying close on 3° south lat., and at an elevation of about 4000 feet above the sea line, which he at once conjectured, from its size and position, as well as from all which the natives told him of its extent, to be a principal source of the river Nile. This lake was called by the natives Nyanza, a term signifying Water, Lake, Pond, or River, to which the English discoverer added the name of his sovereign, christening it Victoria Nyanza. Being prevented at that time from putting his conjecture to the proof, Capt. Speke returned to England, and with the patronage of the London Geographical Society and the British Government, went forth in 1860, on a new expedition, having for his chief object the determination of this specific question. Reaching the coast of East Africa about the first of October, 1860, Messrs. Speke and Grant made their way to the southern point of the Nyanza, and thence going northward they traced one of the principal affluents of the Nile from its source in the lake to its union with the great river itself. This result has been heralded everywhere, in general terms, but having received Capt. Speke's own Report of the journey we prefer to place its details on record here.[1] Their sagacity, perseverance, bravery and success elicit universal commendation. We understand that a volume may be expected from the explorers at an early day, from the press of Wm. Blackwood, Edinburgh.

[1] v. Proceedings Roy. Geog. Soc., Lond., vii, 212–217.

For an illustration of the relations of the Victoria Nyanza to Lake Tanganika, and the River Shire, the reader may consult to advantage a map by Mr. Ernest Sandoz in the American Geographical Society's Proceedings, October, 1862.

Capt. Speke's narrative begins with reminding his hearers that his observations are the results of two visits to the region, and that he has not followed the river from head to foot, but has tracked it down, occasionally touching upon it. His statement blends native information with his own experiences. He then continues,—

"After returning to Unyanyembi (the old point) 3° S. of the lake, in 1861, I struck upon a new route, which I imagined, from the unsophisticated depositions of the ivory merchants, would lead me to a creek on the westerly flank of the Nyanza, situated on the southern boundary of Karagwé. Geographical definitions were here again found wanting, for, instead of the creek to the great lake appearing, a new lake was found, called Luero-lo-Urigi, or White Lake of Urigi, which appeared to have formerly contained a considerable amount of water, but is now fast drying up. Its head lies in Urundi, and, circling round the south and east flanks of Karagwé, in form a mountain valley, is subsequently drained by the Kitangulé River into the Nyanza, but not in sufficient quantity to make any sensible impression on the perennial contents of the Nyanza basin. It is to the west and south of Karagwé that the lake receives its greatest terrestrial supply of water, through the medium of the Kitangulé River, which, in draining the aforesaid Luero-lo-Urigi, drains off the superfluous waters of many minor lakes, as the Akenyara in Urundi; the Luchuru, which is the second of a chain including the Akenyara; the Ingezi and Karagimé; and the little Winandermere, which in Karagwé lies below the capital on its southeastern corner. None of these lakes are large—mere puddles in comparison to the great Victoria Nyanza; but still the Kitangulé, after receiving all their contributions, is a noble river, low sunk like a huge canal, about 80 yards across, with a velocity of about 4 miles an hour, which appears equal to the Nile itself, as soon as it issues from the lake by the Ripon Falls. The question naturally suggests itself, What forms these lakes?—whence originate their waters? It is simply this: the Mountains of the Moon, in which they lie, encircling the northern end and the Tanganyika Lake, are exposed to the influences of the rainy zone, where I observed, in 1862, no less than 238 days out of the year were more or less wet ones. Mashondé, in the upper portion of Uganda, is the first place where, in this second expedition, I obtained a view of the Victoria Lake, called in these more northern countries Luero-White (lo-of) Luta (dead) Nzigé (locust), in consequence of the reputed fact that flights of locusts, in endeavoring to cross these waters, have dropped down from fatigue, unable to accomplish such an extended journey on wing, and, perishing in the lake, have been found dead in dense masses by the boatmen. But, like the word Nyanza, it is also applied to the Nile and its tributaries, thus confounding all inquiry. This is the explorer's greatest difficulty in endeavoring to put together the information which he hears, though it may be overcome by close questioning, even

better with the natives than with the Arabs; for whilst the former regard all rivers flowing, as we do, from head to mouth, the Arab invariably says it runs from mouth to head. In a southerly direction the Uaganda boatmen go as far as the island of Ukerewé, which I saw on my first journey to Muanzae, the southern extremity of the lake; and to the eastward beyond the escape of the Nile, to the northeastern corner of Victoria Lake, where by a strait they gain access to another lake in quest of salt, possibly the Baringa of Dr. Krapf, which he, from information gained through the natives, called Salt Lake, most likely because there are salt islands on it, which reasoning I deduce from the fact that on my former expedition, when the Arabs first spoke to me of the Little Luta Nzigé, they described it as a salt-lake belonging to the great Nyanza; yet not belonging to it, when further pressed upon the subject. The Great Nyanza waters were purely fresh and sweet. They (the Arabs), like Dr. Krapf, merely narrated what they heard. As salt-islands were visited by the natives in search of that mineral, the surrounding waters naturally were considered salt by them, deprived as they were of its connecting links, which included the whole area of ground under consideration within the limits of the drainage system of the Nile. The Arabs, who, it is now very clear, had heard of everything in connexion with the science of physical geography, were enabled to connect what they had gleaned in detached fragments from it. Dr. Krapf further tells us of a river trending from the river Newey, by Mount Kenia, towards the Nile. If such is the case, it must be a feeder to the Baringa, whose waters pass off by the Asua river into the Nile, for the whole country immediately on the eastern side of the Victoria Nyanza is said by the Arabs, who have traversed it for ivory, to be covered with low rolling hills, intersected only by simple streaks and nullahs from this point in Muanza to the side streak, which is situated on the Equator, on the northern boundary of the Victoria Nyanza. Turning now again to Mashondé, and proceeding north along the boundary coast of Nyanza to the valley of Katonga, which, as situated on the quarter of the lake, is constantly in view, the land above the lake is beautiful, composed of low sandstone hills, streaked down by small streams—the effect of constant rains—grown all over by gigantic grass, except where the numerous villagers have supplanted it by cultivation, or on the deltas, where mighty trees, tall and straight as the blue gums of Australia, usurp the right of vegetation. The bed of the Nyanza has shrunk from its original dimensions, as we saw in the case of the Ujiji Lake; and the moorlands immediately surrounding are covered with a network of large rush-drains, with boggy bottoms, as many as one to every mile, even counting at one period a much fuller stream than at the present day, when the old bed was on the present surface of the water, and its breadth was double that which it now presents. The Mountains of the Moon are wearing down, and so is Africa. Crossing over the Equator altogether, the conformation of the land appeared much the same, but increased in beauty; the drainage system was found the opposite, clearly showing where in the north slope of Africa one stream, the Mweranga, of moderate dimensions, said to arise in the Lake, flowed north, and joined the Nile in the kingdom of Unyroro, where its name is changed to Thafa. Far on, another stream,

the Luajerri, followed its example; and then still further on from the center of the Lake Nyanza's coast, issued the parent stream of the Nile, flowing over rocks of igneous character 12 feet high, which the natives, and also some Arabs, designate by the simple name of "stones." I have done myself the honor to christen it the Ripon Falls, after his Lordship, who was the President of the Royal Geographical Society when the expedition was set on foot. Now, proceeding down the Nile from the Ripon Falls, the river first bisected the sandstone hills which extend continuously into Usoga above the coast-line of the lake, and rushed along northward with mountain torrent beauty; and then, having passed these hills—of no great extent—it turned through long flats more like a lake than a river, where, in Unyroro, it was increased by the contribution of the Kaffu and the Luajerri, and continued in this navigable form to the Karuma Falls in Chopi, where again, the land dropping suddenly to the westward, we saw the river rushing along with boisterous violence, but could not follow it, owing to the war which lay upon the track. It was, indeed, a pity, for by common report, not 60 miles from where we stood, the Little Luta Nzigé, which I had taken so much trouble in tracing down its course from the Lunæ Montes, with its salt islands in it, joined the Nile.

The main river was next met with in the Madi country, due north of the Karuma Falls, where it still bore the unmistakable character of the Nile,—long flats, long rapids. The southern half of the Madi was a flat, extending, we believe, to the junction of the Little Luta Nzigé; the northern, a rapid extending down to the navigable Nile, that is to say, the Nile which is navigable its entire length during the period of its flooding; and here it is that the Asua river of which we have heard, draining from the northeast corner of the Victoria Lake, joins; in a rainy season an important feeder, but when low, fordable. The first great affluent, which, indeed, is the only one worthy of remark on the left of the Nile, is the Bahr el Ghazal. The point of confluence presents the appearance of a diminutive lake at a sharp elbow of the Nile, and has hardly any visible stream of its own, whilst the great river winds round with a considerable velocity, carrying as I have said the palms with it. The second affluent in order of position, which, with all the others, is on the right of the Nile, is the Giraffe River, swirling with a considerable stream and graceful round into the parent Nile. Its magnitude and general appearance is like that of a first-class canal, inferior to the Kitangulé River, although not as much as to equal in volume one-third of the Nile at its point of junction. It is navigable to a great distance south; but where it comes from, nobody knows. It cannot be called a mountain river, as we found it full of rosets floating on its surface as in the Nile, evidently showing that both the trunk and the branch are subjected to the same alternations of sluggish flats and rapids. The third is the Southern Sobat River, which was full and navigable. In breadth it is greater than the Giraffe River, but less in velocity; so that we may infer their perennial contents are much the same. Unfortunately, the Northern Sobat was passed without our knowledge, which also being navigable, would make the Upper Sobat, that is to say, the Sobat above the Delta, of far greater magnitude than the Giraffe, unless, indeed, the three streams may be one river still further south, when in its combination the

omparison would have to be drawn with the Nile above it, which it rould very nearly equal; for the Nile, with these additions, has scarcely loubled its importance, considered as it was seen from above entering the Bahr el Ghazal. The Blue River was long assumed to be the Nile only because its perennial powers were never tested. It appears to be a mountain-stream emanating in the country without the rainy zone, but subject to the influence of tropical rains and droughts, at one time full, and empty at another, or so shallow as to be fordable. The suspicion, therefore, that it was the Nile, must of itself appear absurd; for its waters, during the dry seasons, would be absorbed long before they reached the sea. But apart from this feature of the volume of the Blue River, the Nile runs like a sluice in its wonted course; whilst the Blue River, conjoining with the Giraffe and Sobat, describes a graceful sweep. The Atbara, which is the last, is in all respects like the Blue Nile, only smaller. With one more remark I will conclude. In the height of the dry season in the White River, the Blue is freely navigated, owing to the great accessions of the Giraffe and Sobat Rivers, but below the Blue and Atbara Rivers to the sea, the sandbanks obstruct further passage."

UNGER'S SCIENTIFIC RESULTS OF A TOUR IN GREECE AND THE IONIAN ISLANDS.—From the recent work of Prof. Fr. Unger, we derive the following epitome of his observations. His brief tour (March 25–June 10, 1860) was confined chiefly to Eubœa and the Ionian Islands, and the results are contributions to their Botany and Geology. He gives a catalogue of 594 species of living plants collected by him, four of which being new are described in full, *Biatora Ungeri*, *Neckera cephalonica*, *Neckera turgida*, and *Silene Ungeri*, and with them a new variety of *Evernia divaricata*. Some fossil plants were found, especially at Kumi on the east coast of Eubœa, from which place he gives descriptions and engravings of 56 species of a remarkably wide botanical range, belonging to no less than 41 genera and 29 natural orders. The fresh-water deposit which is seen here and in the northern Sporades appears also near the gulf of Smyrna, and even as far to the southeast as the Cilician Mt. Taurus. Specimens from this last locality were examined by our author and described ten years ago.

A geological and topographical chart of Corfu accompanies the work, showing the prevailing Cretaceous limestone (*kreidekalk*) with Tertiary basins in the centre and in the south. The highest elevation is in the north, St. Salvator, 2900 feet.

Several curious natural phenomena are discussed by Unger, as for instance, that at Argostoli on the west coast of Cephallenia, where the gulf waters flow inland through narrow channels disappearing under the rocks. The force of the water in one of them is sufficient to turn the wheel of a mill which has been in operation now thirty years. Where does the water go to? He supposes it to pass by subterranean channels to the salt and

brackish springs on the eastern side of the island, which are only one to one and a half feet above the sea level. The surface of the narrow gulf of Argostoli may be so much higher in consequence of the copious springs flowing into it at its head, as well as from other causes not yet observed. Similar salt springs have been observed in other parts of Greece, as the ancient Rheiti near Eleusis, and may perhaps hereafter be traced to marine sources.

To the question whether, so far as natural characteristics are concerned, the East is susceptible of a revival of its ancient prosperity, he gives an affirmative answer, having shown by comparing ancient testimonies with his own observations that there has been no natural change there of any account. F. P. B.

GUYOT'S PHYSICAL WALL-MAPS OF THE CONTINENTS.—A series of accurate Wall-Maps illustrative of the physical structure of the several continents, and of lesser portions of the earth's surface, has long been much desired by English and American teachers. The excellent maps which are published in Germany have never been widely introduced in this country, from the fact that the nomenclature, explanations and accompanying text are in the German language and are consequently obscure to many who would otherwise make use of the charts. At length, we have been furnished with an American series, which is not merely adapted in this respect to those who are only acquainted with the English language, but which is an original and important contribution to scientific cartography, and will be found in many particulars, as we believe, superior to other similar works.

The author of the maps is Professor Arnold Guyot, of Princeton, N. J., who has been for several years engaged in collecting his materials and in studying the best modes of presenting the generalizations of our knowledge of the surface of the earth. Two or three maps prepared by him were published in Boston several years ago, but although they were highly valued, their cost was too great to admit of their general introduction. Good as those were, the maps now published are much better fitted, in our opinion, for the illustration of geographical science. In their construction, Prof. Guyot has had the skillful aid of his nephew, Mr. Ernest Sandoz, whose ability as a draughtsman has been cultivated in the best European schools, and is all that could be desired in an undertaking of this kind. The result of their combined experience and study is satisfactory in a high degree. Each of these maps indicates by color the chief physical characteristics of the country it represents; the low lands having a green tint, the table lands brown, the mountain ranges black, and the highest peaks white. One or more cross sections are also delineated at the bottom of the map to exhibit in a still more

striking manner the predominant slopes and elevations. Besides this, the marine currents, the lines of equal temperature, the zones of vegetation and other physical phenomena are indicated.

While these maps are not deficient in details, one of their chief merits consists in the fact that what is minute and special is made subordinate to what is general and extensive. By a skillful mode of drawing, those features of a country which constitute its chief characteristics are brought prominently before the eye, while the minor features are less boldly presented. At a glance it is easy to recognize what mountain chains, table lands, or water courses distinguish one continent or region from another; while a more careful scrutiny will bring out some of the details of the structure. The object seems never to have been lost sight of, that in such general maps as these, the essential, the predominant, the characteristic, should be given in clear, bold, lines; while that which is secondary and unimportant should either be omitted altogether or delineated in a subordinate style. Consequently the maps are not encumbered with minutiæ. They are eminently fitted for instruction in a class. Special topography can be acquired in hand-atlases, where an abundance of names is a merit rather than a superfluity; but in the lecture and the recitation such details are confusing to the eye and embarrassing both to the pupil and the teacher.

In addition to the exhibition of natural phenomena, the chief political divisions and the principal towns are also indicated on these maps, in a manner which does not obscure the physical features. The lettering is also well managed. Names are sufficiently frequent but are so printed as not to crowd the map, and indeed so as not to be read at the distance of a few feet. By devices of this kind, a great deal of detail is introduced without overrunning the map, and destroying the simplicity and clearness which are so important.

We have seen completed of this series only the maps of South America and the United States, but we understand that others are ready for publication. (New York: C. Scribner, 1863.)

PROF. WHITNEY ON THE HIGHEST MOUNTAINS OF THE UNITED STATES AND OF NORTH AMERICA.—Prof. J. D. Whitney, Superintendent of the California Geological Survey, discusses briefly in the California Proceedings, ii, 219, the question "which is the highest mountain in the United States and which in North America?" His conclusion is that *Mt. Shasta*, the height of which according to the barometrical measurements of the California Geological Survey, is 14,440 ft., probably overtops all other peaks within the limits of the United States. Mt. Hood, sometimes called the loftiest peak of the Cascade Range, is probably not so high as Mts. Shasta, Rainier, or Adams, and by no

means entitled to the supremacy of the chain, although one of the highest points in it. Dr. Vansant's trigonometrical measurements in 1860 are reported to have given the height of Mt. Hood as 11,934 feet.

Mt. St. Elias has generally been considered the highest mountain in North America on the authority of Malespina's manuscripts, discovered by Humboldt in the archives of Mexico, which assign to it an elevation of 17,854 feet. The following circumstances, in the view of Prof. Whitney, justify us in believing that Malespina's measurements were grossly incorrect.

"In the first place," he remarks, "La Perouse measured this mountain in 1786–8, and made it only 12,661 feet high; again, on the English Hydrographical Charts, it is given at 14,970 feet. But, secondly, Vancouver, in his description of the mountain, says expressly that the snow line does not descend very far down its sides, which would be an absurdity, if it was really 17,000 feet high in a latitude of sixty degrees. It is probable that the height given by the British Charts, probably from Captain Denham's measurement, is nearer the truth; and, if so, then St. Elias is nearly 3,000 feet lower than Popocatapetl, and also lower than several other points in Mexico, and lower than Mt. Brown and Mt. Hooker, in British Columbia, according to the usually adopted figures, viz: 16,000 and 16,750 feet. But, it may be said with truth, that these figures given by Douglas are of little value, and that they are considerably above the real heights.

In regard to the height of the Mexican volcanoes, there is no uncertainty. They have been carefully measured by Sonntag, whose barometrical observations agree with the trigonometrical ones of Humboldt, made more than fifty years before. According to Sonntag, Popocatapetl is 17,783 feet in height, and must, therefore, be allowed the honor of standing at the head of the mountains of the North American continent."

Prof. J. D. Whitney's Survey of California—Proposed Maps.—The California Geological Survey is likely soon to give us much more precise information respecting the physical geography of that state than can now be obtained from all other sources. The following extract from a communication to the California Academy by Prof. J. D. Whitney, the State Geologist, exhibits what has already been accomplished.

"California is covered by a vast net-work of mountain ranges, separated by comparatively narrow valleys, with the exception of those of the Sacramento and San Joaquin, which do not, together, cover more than one-fifteenth of the area of the State. The remaining fourteen-fifteenths may be called mountainous, as the valleys include but a small portion of its surface. Into this mountainous region no accurate surveys have ever been carried; even the General Land Office work stops at the base of the mountains. A few ranch lines have been run among the moderately elevated portions of the Coast Ranges; but, as a general thing, the genuine Mexican grants were limited to the plains.

Without considerable topographical work in connection with the geological survey we should, then, be entirely unable to carry on our geological work with any pretense to accuracy, as we could neither locate our observations nor make our descriptions of the country intelligible. The authority for doing something for the increase of the geographical knowledge of the State is found in the clause of the act authorizing the survey, which requires "proper maps" to accompany the reports.

What has been done, up to the present time, in this department may be briefly recapitulated as follows:

A series of maps, forty-nine in number, has been compiled by Mr. Hoffman from the original documents at the United States Surveyor-General's Office; the scale of these is half an inch to the mile. They contain a compilation of nearly all that is known at that office in regard to the geography of the State. The maps, as thus blocked out, have been used by us in the field, by filling in the topography wherever our route has laid.

The maps which have been or are now being prepared for publication are:

1st. A map of the vicinity of the Bay of San Francisco, on a scale of half an inch to the mile, four feet by three; it extends from near Santa Cruz on the south to Napa on the north, and from the Pacific to Corral Hollow, east and west. The area of land which it covers is 4,248 square miles, which is just twice that of the State of Delaware, and only lacks two hundred square miles of equalling that of Connecticut. As near as can be ascertained, it contains one third of the population of the State, and has about thirty inhabitants to the square mile—the average density of the population of California being but little over two to the square mile. This map, on which all the details of the topography are given, as minutely as the scale allows, is nearly completed, and will be soon ready for the engraver.

2d. A detailed map, on a scale of two inches to the mile, of the vicinity of Mount Diablo; this is about two and one-half by three feet in dimensions, and includes the most important coal mining district yet known to exist in the State. The map can be made ready for the engraver in a few days.

3d. A map of the Coast Ranges, from the Bay of Monterey south to Santa Barbara. It is about three feet by two and one-half in dimensions, is on a scale of six miles to the inch and embraces about 16,000 square miles of territory. To complete it will require about another year's work in the field with two sub-parties.

4th. Map of the Washoe silver-mining region—three and one-half by two and one-half feet in dimensions, on a scale of two inches to the mile —and extending over all the important mining ground of the district. This map is from an accurate trignometrical survey by V. Wackenreuder; it is nearly completed.

5th. Map of the Comstock Lode, on a scale of four hundred feet to the inch, completed.

6th. Map of the central portion of the Sierra Nevada; scale not yet determined on. Extensive surveys have been made by Mr. Wackenreuder for this part of the work, and these will be continued during the present season.

Of the above mentioned maps, Nos. 1 and 2 will accompany the first volume of the Report. Nos. 4, 5, and probably 6, the second volume.

It is intended, if the survey is carried to completion, to construct a final map of the State on a scale of six miles to the inch, in nine sheets, each about three feet square.

In addition to the regular topographical work, an extensive series of barometrical observation has been made, for the determination of altitudes, some two hundred and fifty important points having been ascended and measured. The most interesting operation in this department was the determination of the height of Mount Shasta, which, by an elaborate series of observations, we found to be 14,440 feet above the sea level. This is the first of the lofty volcanic peaks of the Sierra Nevada which has been accurately measured.

In the department of geology proper, our explorations have extended over portions of forty of the forty-six counties into which the State is divided; and when it is remembered that the average size of a county is equal to half that of the State of Massachusetts, (California having just twenty-four times the area of that State,) some idea of the magnitude of our work may be obtained. The chain of the Sierra Nevada may be parallelized with that of the Alps for extent and average elevation; while the Coast Ranges are nearly as extensive as the Appalachian chain of mountains.

We have obtained a pretty clear idea of the general structure of the Coast Ranges from Los Angeles to Clear Lake; the vicinity of the Bay of San Francisco has been worked out in considerable detail, including all of San Francisco, San Mateo, Santa Clara, Alameda, Contra Costa, and Marin Counties, with portions of Santa Cruz, Solano, Napa, and Sonoma. Considerable field-work has been done in the Sierra Nevada, chiefly in the lower portion of the range between Mariposa and Shasta Counties. Our observations have also been extended to the Washoe Region, and we have received considerable collections of fossils from the Humboldt Mining District, (known by this name on the Pacific Coast, but designated on Warren's Map as the "West Humboldt River Range," and in longitude 118°) by which we have been able to fix the age of the formations in that region."

Recent Australian Explorations.—Some months have passed since we have made reference in these pages to the important researches which have been making to discover the physical structure and natural characteristics of the interior of Australia. From the Lond. Geog. Soc. Proceedings (iii, 82), to which we are indebted for so much information that illustrates the progress of British enterprise, we draw the following extracts.

"1. *Explorations from Adelaide across the Continent of Australia;* by J. McDouall Stuart.—This expedition proceeded along the previous route until they reached the point attained by Mr. Stuart in 1861, from which he was obliged to retire in consequence of the inability of his small party to penetrate further.

The dense scrub that had in 1861 formed an insurmountable barrier was penetrated after six weeks' incessant labor, and the other side was reached in safety and without loss.

On getting into clear country again and taking observations, they found themselves in lat. 16° 40′. Ten miles further on, or lat. 16° 30′, they struck on a large river, apparently a branch of the Roper River, which they followed down until its confluence with the main stream, known as the Roper River. They found that it took its source in some rocky and hilly land, through which they crossed several creeks running in a northeast direction, until they reached the table-land in lat. 13° 50′ and in long. 132° 30′. They crossed this table-land and came upon a large river with a strong current, running through well-grassed country, admirably adapted for grazing and agricultural purposes. The river ran in a northwest direction, and the party followed its course for a considerable distance, until in lat. 12° 50′ and long. 131° 40′ it changed to due north. On this course they travelled for about 30 miles, and then struck due east for about 10 to 15 miles; after which due north to the seaport in Van Diemen Gulf, which was reached on the 24th of July, 1862; and on the following day they planted their flag on the beach amid great cheering from the party.

The point on the coast reached was a promontory marked on the Admiralty Charts as being 30 miles east of Cape Hotham.

The river, which they followed, ran about 40 miles parallel with a river marked on the map as the Adelaide, the difference in the longitude being only from 6 to 12 miles. Stuart passed through much good country, well fitted for agricultural and pastoral purposes. Leichhardt had previously seen this tract, and noticed it in terms not less favorable. Even in the scrub water seems to have been found in sufficient quantities to satisfy the wants of all the party, including the horses, obviating any necessity for carrying a supply from camp to camp beyond Newcastle Water.

They were not nearly so fortunate on the return route, being more than two whole days before they obtained a necessary supply—the only occasion on which they were inconvenienced by its want.

Their provisions held out till the latter part of their journey, when they were compelled to sacrifice three of their horses for food.

Mr. Stuart met M'Kinlay at the Kapanda Station; and at the Adelaide Station Mr. Howitt's party were among the first to welcome him home after his laborious but successful mission.

2. *Exploration of the Interior of Australia;* by Mr. Landsborough.—Mr. Landsborough, who had previously (Proceedings, vol. vii, p. 5) explored southwesterly for 300 miles, started from the Gulf of Carpentaria on the 10th February, 1862, following the Leichhardt for some distance, and turning off near the falls in a direction E.S.E. over a grassy country. This terminated in some picturesque hills, among which it was thought that a sheep establishment would be well placed. Beyond the hills there was more wood and less pasture. The Flinders was crossed on the 19th, followed for some time, and finally left on the 1st March in lat. 20° 3′. Near Mounts Little and Brown the river is deep, and seems perennial. The country is probably thinly inhabited, as the

first native was seen on 1st March. The rains in this month were heavy, and rendered the ground soft and difficult. The pasture continued good, with sufficient wood for fuel; but the country would not bear a great amount of live stock, and both water-tanks and annual grass sowing would be necessary. While still on the Flinders a blue range of mountains was visible, and named Branston Range; another mountain was named after Frederick Walker. On the 22nd March the party encamped on the Jardine Creek, an affluent of the river which they had followed so long. On the 26th, while tracing out the neighboring creeks, draytracks were seen, probably those of persons who have occupied Bowen Down, a district discovered two years previously by Mr. R. Buchannan. On the 29th the party reached Landsborough Creek, leading to Thomson River, where Landsborough came upon an old camp of his own. About lat. 22° 58′ they also fell in with some fine looking natives, who said that they had seen an exploring party, but no camels. Further on the natives possessed some iron tomahawks, which they said they got from another tribe on the river to the southward. Continuing their course in a S.S.W. direction, and partly under the guidance of natives, some of whom, however, seemed disposed to be hostile, the party on the 15th April reached a creek which they named Dunsmore, and which led them on the 17th to Cooper River. The country passed through and explored during the next four weeks in the neighborhood of the same river was generally of an indifferent character, and towards the east the horses on more than one occasion suffered from want of water. Marks on many of the trees showed that it had been visited. On the 21st of May they reached the station of a settler on the Warigo River; and thence passed by Bumaranah on the Darling on the 2nd of June, to Menindie and Melbourne by the usual route.

3. *Explorations in the Interior of Australia by the Burke Relief Expedition, under* Mr. J. M'Kinlay.—The South Australian Burke Relief Expedition was originally organized with the view of ascertaining the fate of, and affording relief to, that portion of the Burke expedition which perished upon Cooper Creek, after achieving the task so unsuccessfully undertaken by previous explorers. It left the South Australian capital on the 14th of August, 1861, and reached the confines of the settled districts on the 26th of the following month. On the 27th of September the party, consisting of nine whites and two natives, with twenty-four horses, four camels, twelve bullocks, one hundred sheep, and dog, crossed Lake Torrens, and fairly commenced their arduous task. Though not at that period occupied, the country to the north of Lake Torrens had been visited by many of the settlers upon the southern margin; and one of them undertook to guide the party to the first of a series of fresh water lakes, about fifty miles in advance. It took several days to reach Lake Hope, as the heat of the weather completely knocked up the bullocks; but by the aid of the camels the expedition was extricated. During the stay of the party at the lake district, an excursion was undertaken with the view of ascertaining the truth of a report that some whites were living upon a raft in one of the creeks in the vicinity. On the banks of the creek were marks of a

European encampment; the dung of camels proving that it must have been one of Burke's, while *en route* to or from the Gulf to Cooper Creek. The remains of one of the party, since ascertained to be Gray, and showing traces of a violent death, were found slightly covered with earth and boughs; and at a little distance two holes very like graves. A subsequent visit to Cooper Creek left but little doubt about the fate of Burke.

In the course of December the main camp moved to a double lake, called Appocaldradille. From this point a scout was undertaken to both north and east without finding water for 50 miles. The party consequently moved on to a deep creek, called Appanbara, where, however, they endured much suffering from heat and bad water. After the first rains in February, it was thought practicable to traverse the stony desert. For some days the route lay along a creek called 'Cariduro' (probably Eyre Creek of Captain Sturt), where several traces of Burke's party were found. At this period of the journey the main difficulties were due to the floods, which rise very rapidly, and render the whole country a sea either of water or of treacherous mud. Forced by the flood to continue a northeast direction, over an undulating stony country, the expedition came at length to vast grassy plains, bounded by volcanic hills, among which were obtained some of the most striking views on the journey. On the 7th of May the party reached the gorge through which the Leichhardt flowed towards the Gulf. On the 20th the camp nearest the sea was made, at a point where the tide rose 8 or 9 feet, and where sea anemones floated past in large numbers. On the 21st the expedition commenced its return *viâ* Port Dennison; and on the 2nd of August, after great fatigues and the loss of most of the cattle, the first station in the settled districts was reached."

Dr. Livingstone's recent exploration of the Niassa Lake.—The following synopsis of a recent communication from Dr. Livingstone respecting his explorations of one of the Lakes in Southern Central Africa, is taken from the London Geographical Society. (Proceedings, vii, 18.)

"*Exploration of the Niassa Lake;* by Dr. Livingstone and his Party.—After establishing the members of the University Mission in the neighborhood of Mount Zumbo, Dr. Livingstone proceeded with his party to explore the Lake Niassa. They carried a four-oared boat in three weeks past Murchison's Cataracts, which extend through 35 miles of latitude, and launched her on the upper waters of the Shiré. They entered the lake on September 2, accompanied by a score of natives, and explored its western coast for 200 miles, travelling until they were compelled to return from want of food, due to the recent extermination of the northern coast tribes by savage warfare. Part of the expedition went on foot and part in the boat: the latter were never able to cross the lake or venture far from shore, owing to the suddenness and extraordinary violence of the storms. They ascertained its breadth by rough triangulation, whenever the haziness of the air allowed the opposite shore to be seen, but no certain knowledge was obtained in regard to its northern extremity. The lake has something of the boot shape of Italy: it is narrowest at the

ankle, where it is 20 miles, and broadens gradually to 50 or 60 miles. Its western shore presents a succession of sandy bays, each divided from its neighbor by a bold headland, with detached rocks extending some distance out to sea. Much of the land adjacent to the lake is low and occasionally marshy: it is tenanted by water-fowl and some elephants. Eight or ten miles from the shore are ranges of high and well-wooded granite hills, nearly parallel to its course, and presenting in several places a magnificent succession of distances. The intervening plane narrows towards the north; where Dr. Livingstone turned, it disappears altogether. The depth of the lake is readily to be traced by the changing color of its surface. A belt of bright green water fringes the shore, and varies in breadth from a few yards to several miles: beyond this is the deep blue water of the body of the lake. A sounding-line of 200 fathoms was found insufficient to reach the bottom one mile from shore. The temperature of the water is 72° Fahrenheit; its rise in the rainy season is 3 feet. Five affluents were seen on its western coast, of inconsiderable size: their united volume was far inferior to that of the waters of the Shiré.

Natives, of essentially one tribe and language, throng the southern portion of the lake. Their villages are so close together as frequently to form a continuous line of habitations. They are hard-working fishermen and good cultivators of the land: they were reasonably civil to Dr. Livingstone's party, and exacted no dues for the right of transit. The slave-trade is unfortunately active. An Arab had built a "dhow" (boat) on the lake, in the latitude of Ibo, for the purpose of ferrying slaves across. Dr. Livingstone's present endeavor is to transport a steamer to the Niassa for the purpose of checking this traffic as far as may be practicable, and also with the object of further exploration."

Exploration of the River Vermejo, in the Argentine Confederation—Mr. Porter C. Bliss.—The Argentine Confederation lately sent an expedition up the Vermejo River, one of the principal branches of the River Parana, to examine its capacity for navigation and the advantages of the districts which it drains, for commercial enterprise. Connected with the party was a young scholar from New England, Mr. Porter C. Bliss, who was especially charged with inquiries relative to the Indians upon the route. For such investigations he was unusually fitted, having long paid particular attention to the characteristics of the aborigines of the Continent. A correspondent of the New York *Daily Times*, writing from Buenos Ayres, Sept. 28, 1863, reports that Mr. Bliss has returned to that city with an abundance of new and important information in respect to the region which he has visited. Among the subjects to which his attention seems to have been directed, is the adaptation of the country to immigrants, for whom it presents many attractions. It is suggested as a favorable home for the freedmen of the South. From our personal acquaintance with Mr. Bliss, we shall look with interest for a full and authentic statement of his observations.

ART. X.—*Review of Holbrook's Ichthyology of South Carolina.*[1]

THIS volume is for the most part a second edition, the first having been published in the year 1855, but suspended with the issue of the tenth number. The plates, stones, and original drawings for the work having been subsequently destroyed by the fire which consumed the Artists' Buildings in Philadelphia, the government of South Carolina interposed and assumed the cost of its reproduction. "The delay in the publication of the work has, however, enabled" Dr. Holbrook "to give more accurate and highly finished plates and to correct some errors of the letter press. As but few numbers of the work were distributed previous to the destruction of the original plates, ... and the present edition is so much improved," the author "decided to recall the former numbers and to replace them by those of the new edition, without expense to the present holders." It is to be regretted that the new edition was not more freely opened to the patronage of the public, and to obviate the inconvenience to naturalists caused by the restriction of its circulation, the present notice is given.

In the second edition, the generic and specific descriptions are in most cases entirely the same as those of the first, the principal deviations occurring in the family called Ichthelidae. The plates are also arranged in the same manner, the only exception relating to XXIII and XXIV which had the numbers reversed in the first, and the interposition of an additional plate between XXVI and XXVII which last in the present is consequently called XXVIII. The figures themselves are mostly new and are as a rule superior to those of the original edition; the worst are the ones illustrating the scales of the Sparoid fishes and another intended to represent the preoperculum of "*Homoprion lanceolatus.*" Dr. Holbrook, adopting the fashion introduced in this country of figuring three scales of each species, has caused to be thus represented those of the Sparoids, but none give an idea of the type of structure peculiar to the representatives of that family and so characteristic of it. When the scales are so especially figured, we might at least reasonably expect a close approximation to correctness, and when it is not found, and it thus becomes apparent that the author himself has not paid special regard to them, we may well ask why the time and space given to these figures could not have been more advantageously bestowed in illustrating some more important characters. By what strange optical delusion a preoperculum, like that represented in the enlarged view of that bone in *Homoprion lanceola-*

[1] Ichthyology of South Carolina, Vol. I. By JOHN EDWARDS HOLBROOK, M.D., &c., Charleston, S. C. Published by Russell & Jones, 1860.

tus, could have been imagined by the artist, it is difficult to conjecture. With these remarks, however, special criticism may end, for although some of the other figures might be much improved, most are tolerably accurate.

With regard to the nomenclature of the species, little need be said. The names which will probably be for the most part adopted are given below; those specially interested in the subject are referred to the discussions in the Proceedings of the Academy of Natural Sciences of Philadelphia, &c. Dr. Holbrook has been frequently unfortunate in the application to his fishes of former names, especially in the cases of the synonymy of his *Caranx hippos* and *Homoprion xanthurus*. The *Scomber hippos* L., identified with the first, belongs to a different genus, as does also the *S. chrysos* of Mitchill. Under *Homoprion xanthurus*, the *specific character* is based on an extract from Cuvier & Valenciennes' description and radial formula of *Leiostomus xanthurus*, while the body of the description and the figure apply to *Bairdiella argyroleuca*—the *Corvina argyroleuca* C. & V.—a species of a different subfamily. If Dr. Holbrook had been correct in his application of Lacépède's name *Leiostomus xanthurus*, he would have been subject to the charge of a perversion of that author's generic name, but by a happy error, he has correctly retained it in its true sense.

On the other hand, some former names, concerning whose application there is no reasonable room for doubt, have not been at all accepted; such are the Linnæan *Labrus auritus* and *Gasterosteus Carolinus*. The former was evidently proposed for the species called by Holbrook, *Ichthelis rubricauda*—the *Pomotis rubricauda* of Storer, well characterized in the terse Linnæan phrase "opercula apice membranaceo, *elongato*, obtuso, *nigro*,"[2] and even rendered more certain as to its application by the *doubtful* reference to Catesby's figure of *Pomotis aureus*. It is however due to Dr. Holbrook to state that it appeared to him "certain that the specific name *auritus* was not applied to the "*Pomotis vulgaris*," and that Linnæus's description might "possibly apply to" either *P. rubricauda* or *P. incisor*. Probably none familiar with the subject will hesitate to retain the *Linnæan* name instead of *rubricauda*. The *Gasterosteus Carolinus* was as evidently intended for Holbrook's *Bothrolaemus pompanus*, notwithstanding this author's opinion to the contrary.[3] The latter species, it may be here remarked, has served at different stages of development, as the type of three genera, and Holbrook's *Bothrolaemus* is founded simply on very old individuals of *Trachynotus* in which the teeth had fallen out.

As Dr. Holbrook has not uniformly adopted a systematic ar-

[2] Labrus auritus *Linn.* Syst. Nat., ed. xii, vol. i, p. 475.

[3] See Proc. Acad. Nat. Sciences, Philad., 1862, p. 439.

rangement, but has scattered some species in places where they do not belong, the species given under a family name cannot be considered as members of that family, even in the author's opinion, and many of those have been referred to their proper ones in foot notes to the text. *Labrax*, *Grystes*, *Serranus*, *Diplectrum*, *Rhypticus* and *Centropristes* are not Ichthelidæ, but Percidæ; *Pagrus* and *Serranus nigritus* not Sciænidæ, but severally Sparoid and Percoid; and finally *Trachinotus* and *Hæmulon* are not Scopelinidæ, but respectively members of the Scombroid and Sciænoid families as understood by Dr. Holbrook.

With regard to the systematic arrangement thus corrected, it may be remarked that it is not an exposition of the views now prevalent concerning the limits of the families. All the Scombridæ of Holbrook are Carangoids, except *Cybium*, *Elacate*, *Echeneis* and perhaps *Temnodôn*, members of as many different families. *Ephippus* scarcely belongs to the same family as *Chætodon* and its allies; *Hæmulon* and *Pristipoma* are rather Sparoids than Sciænoids, and at least do not belong to the latter family. *Lobotes* is the type of a peculiar one, and finally *Saurus* is the representative of another.

The most important modification in the arrangement is undoubtedly the foundation of the family Ichthelidae for the reception of the North American fresh water Percoids of Cuvier with six branchiostegal rays. Adopting the family of Percidae with the boundaries established for it by Sir John Richardson, he has considered that the Theraponidae of that author taken from it should be itself subdivided, and the family of Ichthelidae is therefore proposed for some of its constituents. The only positive character of the family mentioned by Holbrook which would remove it from the typical Percoids is the presence of only six branchiostegal rays.[4] As such, if strictly adhered to, would necessitate the expulsion from the latter of *Dulés* (auriga) *Percilia*, &c., and their transference to the Ichthelidae, the character is not the true one, and is of very secondary importance in itself. The group of genera embraced under Ichthelidae is however so natural, and its representatives so well distinguished from the true Percoids by their physiognomy, that it is probable that the family itself is a natural one; it has indeed more resemblance to the Cichloids, and its species hold the same place in North America that those fishes do in the Southern Continent and in Africa. Like them, the Ichthelidæ construct a rude nest, guard their young and are the most characteristic Acanthopterygian types of their respective regions. Their arrangement of colors and the variation in the number of anal spines are analogous, and their forms simulate each other. That form is

[4] Dr. Holbrook gives to Grystes in the new edition, "branchiostegal rays seven" instead of "branchial rays six" as formerly, but in a note adds that "sometimes *there are but six rays.*"

distinguished by the equal development of, and the correspondence of, the regions of the body above and below the axis, while in the Percoids and others, these regions are obliquely opposed. It is therefore probable that future investigation will place the family on a firm basis. The family itself is composed of two very distinct types which must be regarded as subfamilies; the LEPOMINÆ distinguished by the very much greater development of the dorsal than the anal fin, their termination at the same vertical behind, and the equality of their respective soft portions; the EUCENTRARCHINÆ, in which the dorsal and anal fins are nearly or quite equal and obliquely opposed, so that the end of the anal is considerably behind the vertical from that of the dorsal; the soft portion of the anal is longest. These two subfamilies embrace a number of genera; Dr. Holbrook has admitted "*Pomotis, Ichthelis, Pomoxis, Ambloplites, Calliurus* [Ag.][5], &c., Raf., *Centrarchus* and *Bryttus*." The *Pomotis chætodon* Bd., *P. obesus*, Grd., *Centrarchus pomotis*, Bd., *Ambloplites interruptus* Gd., and *Pomoxis hexacanthus* Ag., are types of as many additional genera; that typified by *Pomotis chætodon* may be called MESOGONISTIUS on account of the peculiar angulation at the dorsal spine; *P. obesus* (n. g. ENNEACANTHUS) is distinguished by the nine spines of the dorsal fin; *Centrarchus pomotis* (ACANTHARCHUS), by the elliptical form, cycloid scales and convex caudal; the *Ambloplites interruptus* has been already separated under the name of ARCHOPLITES; finally, *Pomoxis hexacanthus*, (HYPERISTIUS) is removed from *Pomoxis* on account of the more oblique mouth, less produced snout, and the presence of seven or eight dorsal spines. Of these genera, *Centrarchus* Ag., *Hyperistius* Gill, and *Pomoxis* Raf., belong to the subfamily Eucentrarchinæ, while all the others are Lepominæ.[6]

While we have been thus obliged to dissent from Dr. Holbrook in many of his conclusions, we would at the same time indicate our appreciation of his great zeal in the cause of science, and his laborious and pains-taking endeavors to perfect his work. When, indeed, we recall that after having had engraved many years ago at least eight plates representing twice that number of species for a work on Southern Fishes of the Atlantic slope; after having published at least one part of a "Southern Ichthyology"[7] with fresh plates in 1847, he suppressed both and issued in 1855 under another title the work now reviewed, and that he

[5] CHAENOBRYTHUS Gill (type *Calliurus melanops* Grd.).—*Calliurus* Raf.=*Grystes* Cuv.=Micropterus *Lac.*

[6] A synopsis of the family of Ichthelidæ, or Centrarchoids, will be hereafter published in the *Proceedings of the Academy of Philadelphia*. There the synonymy of the genera, so much complicated by the mischievous Rafinesque, will be also discussed and a rectification of the nomenclature attempted.

[7] "Southern Ichthyology: or a Description of the Fishes inhabiting the waters of *South Carolina*, Georgia and Florida." New York and London, Wiley & Putnam, *1847. I have seen only one number of this* (II), including pages 1 to 32 and plates

withdrew as much as possible that last publication from cir-
n and issued a new edition of it with so slight modifica-
ı 1860,—we cannot withhold the praise of the most con-
ous desire on his part for perfection, and the wish that the
lume of the final work shall be followed by others. It is
r, doubtful whether the enterprising little state at whose
e the last edition of that first volume was published will
le soon to continue its encouragement of the abstract
s, and we may therefore probably hope in vain for the
tion of the work. The following list of the species de-
under Holbrookian names, with references to the pages
second edition, first edition, plates and figures of second
, and names known to us, will therefore be useful. For
nily relations of several of the species, the reader is
l to the remarks on a previous page. The list is rendered
necessary by the impossibility of the recall of the first
which has already been referred to in so many works
the great difficulty if not impossibility of obtaining copies
second edition.

Percidæ.					
flavescens,	2	2	I,	1.	
Ichthelidæ.					
otis vulgaris,	8	6	I,	2,	(Pomotis) aureus.
elis incisor,[1]	12	13	II,	1,	Lepomis incisor.
rubricauda,[2]	15	10	II,	2,	Lepomis auritus.
archus irideus,	18	15	III,	1,	Eucentrarchus (irideus).
x Americanus,	20	21	"	2,	Morone Americana.
lineatus,	24	17	IV,	1,	Roccus lineatus.
es salmoides,	28	25		2,	Micropterus salmoides.
nus erythrogaster,	32	29	V,	2,	(Epinephelus) erythrogas-
ctrum fasciculare,	35	32		1.	[ter.
oxis hexacanthus,	39	36	VI,	1,	Hyperistius caroliniensis.
ticus maculatus,	42	39		2,	Promicropterus maculatus.
opristis atrarius,	45	42	VII,	2,	Centropristis atrarius.
" trifurca,	49	47		1,	Triloburus trifurcus.
Sparidæ.					
s ovis,	53	51	VIII,	2,	Sargus probatocephalus.
don rhomboides,	59	56		1.	
Scombridæ.					
odon saltator,	64	62	IX,	2,	Pomatomus saltatrix.
m maculatum,	68	66		1,	Apodontis maculatus.

illustrating *Umbrina alburnus* (I, 1) *U. littoralis* (10, I, 2) *Micropogon s*, (12, II, 2) *Corvina ocellata* (17, II, 1) *Leiostomus obliquus* (21, III, 1) *Surinamensis* (25, III, 2) *Elacate canada* (30, IV, 1) *Ephippus gigas* (IV, 2). ounced on the cover of the second part that "No. I, containing the Ana- portion of the Work will be published with No. VI, and in the "Notice" to edition of the Work reviewed, it is affirmed that "two numbers were pub- der another title in 1845." The number noticed is, however, the only one ch we are acquainted.

otis incisor, 1st ed. [2] Pomotis rubricauda, 1st ed.

Seriola Carolinensis,	72	70	x, 2, Halatractus Carolinc
" zonata,	75	73	1, Halatractus zonatu
" chloris,[3]	79	77	xi, 1, Chloroscombrus ch
Bothrolæmus pampanus,	83	81	2, Trachynotus Caroli
Caranx defensor,	87	85	xii, (sup.) Carangus chry
" hippos,	90	88	(inf.) Paratractus pisq
" falcatus,	94	92	xiii,(2=sup.)[5] Carangops fa
" Richardi,	96	94	(1=inf.)[6] Carangus fa
Elacate canada,	97	95	xiv, 2,[7] Elacate niger.
Echeneis vittata,[4]	102	101	1,[8] Echeneis albicaud
Family Squamipinnidæ,			
Ephippus gigas,	107	105	xv, 2, Parephippus gigas
" faber,	110	108	1, " fabei
Family Sciænidæ.			
Pogonius cromis,	114	112	xvi, 2.
" fasciatus,	119	118	1.
Hæmulon chrysopteron,	121	120	xvii, 1.
" arcuatum,	124	123	2.
Otolithus regalis,	129	127	xviii, 1, Cynoscion regalis.
" thallassinus,	133	132	2, " thalass
" nothus,	134	134	xix, 1, " nothus.
" Carolinensis,	136	133	2, " Carolin
Umbrina alburnus,	137	136	xx, 1,[9] Menticirrus alburn
" littoralis,	144	142	2,[10] " littora
Micropogon undulatus,	146	145	xxi, 1.
Corvina ocellata,	150	149	2, Sciænops ocellatu
Larimus fasciatus,	154	153	xxii 1.
Pristipoma fulvomacu-		156	2, Orthopristis fulvon
latum,[11]	157		latus.[12]
Leiostomus obliquus,	160	163	xxiii,[13] (sup.=1)
Homoprion xanthurus,	164	170	(inf.=2[14]) Bairdiella argyrol
" lanceolatus,	167	168	xxiv,[15] 1, Stellifer lanceolat
Lobotes Surinamensis,	169	159	2.
Pagrus argyrops,	174	175	xxv, 1.
Serranus nigritus,	177	173	2, (Epinephelus) nigi
Family Elopidæ.			
Elops saurus,	180	179	xxvi, 2.
Family Scopelinidæ.			
Saurus fœtens,	187	184	1, Synodus fœtens.
Trachinotus glaucus,	192		xxviii,[16] 1.
Hæmulon quadrilineatum,	185		2.
Family Esocidæ.			
Esox affinis,	198		xxviii,[17] 1.
Esox Ravenelii,	201		2.

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[3] Seriola cosmopolita, 1st ed.
[4] Echeneis lineata, 1st ed.
[5] Upper fig., 1st ed.
[6] Lower fig., 1st ed.
[7] Fig. 1, 1st. ed.
[8] Fig. 2, 1st ed.
[9] Fig 2, 1st ed.
[10] Fig. 1, 1st ed.
[11] Hæmulon fulvomaculatus, 1st ed.
[12] Pl. XXIV, 1st ed.
[13] *Fig. inf.=2*, 1st ed.
[14] Fig. sup.=1, 1st ed.
[15] *Pl. XXIII*, 1st ed.
[16] Not in 1st ed.
[17] *Plate XXVII*, 1st ed.

ART. XI.—*U. S. Coast Survey Reports for the years* 1861 *and* 1862.

THESE volumes embrace the history of progress of the important public work to which they relate, for the two years following the first of November, 1860. It is gratifying to observe that neither political troubles nor civil war have had the effect to arrest an undertaking no less interesting to science than valuable in its bearing upon the material prosperity of the country. In the first of the years above referred to, indeed, the plan of operations was laid out without reference to any probable interruption from unforeseen causes; and in the midst of the agitations which disturbed the public mind during the fall and winter of 1860–61, the operations of the survey went on upon the southern coast, from Virginia to Texas, without disturbance. The usual amount of work for the season had been accomplished by most of the parties before their proceedings were suspended in consequence either of actual or of threatened violence. Operations upon the northern coast were of course undisturbed, but the distribution of labor was somewhat modified during the summer of 1861, in consequence of the state of things in the vicinity of Chesapeake Bay.

During the second of the years to which these reports relate, the services rendered by the officers of the survey upon the coast and rivers of the insurgent states, though not directed so entirely as before to the systematic prosecution of the general plan of the survey, have been probably of more immediate value to the government than if they had been so. They have recovered to the use of our naval expeditions, and of our blockading squadrons, the channels and sailing lines which had been lost through the careful removal by the insurgents of all the buoys, beacons and other artificial indications by which they had been distinguished; they have sounded out new channels among the islands occupied by our forces on the southern coast, and in the sounds and inlets of the same region; and they have explored the changes which had taken place in channels previously known, and ascertained their magnitude and extent. In this way they have contributed very materially to the security of our navy and to the efficiency of the blockade. In some cases they have more directly aided in the success of the expeditions with which they have been connected, by surveys preliminary to the planning of an attack; as at Fort Jackson, where the positions of the mortar vessels and their distances from the fort were determined by means of a triangulation carried on directly in sight of the enemy; or as, in the interior, they have in many instances secured topographical information of the greatest value, by operations sometimes conducted immediately under fire.

In the mean time, upon all that large portion of the coast which the rebellion could not reach or affect, the survey has steadily advanced without any modification of its plan, though with an activity somewhat reduced in consequence of the reduction of the appropriations for this work since the commencement of the war. This reduction has been considerable when compared with the total of the appropriations themselves—amounting to from twenty to forty per cent—but in absolute amount it is so inconsiderable as to excite a doubt as to the wisdom of the policy which has suggested it. It is certain that the coast survey is worth to the country very greatly more than its cost. There can be no sort of doubt that it has already indirectly paid for what has been expended upon it, a hundred times over. Nor can there be any greater doubt that its value grows with every stride of progress it makes toward completion. While, therefore, the government is engaged in the prosecution of naval and military operations of such magnitude that its average daily expenditure exceeds by four or five times the total annual cost of this survey, and while the survey has proved itself to be one of the most efficient instrumentalities contributing to the success of those operations, the insignificant saving secured by this curtailment would seem, in view of an enlightened economy, to be of very questionable advantage. Indeed had there never been any survey of the southern coast before the war began, it may safely be said that an efficient blockade of the insurgent states could never have been maintained at all.

Leaving these matters, however, to those to whom they belong, we will proceed to state, briefly, the results of the operations of the survey up to the year 1862. The area covered by the triangulation at that time amounted to upwards of fifty-four thousand square miles, within an extent of sixty-two thousand square miles embraced by the reconnoissance. The extent of coast developed amounted to more than four thousand five hundred miles, and the length of shore-line to twenty-three thousand miles. The number of geographical points determined amounted to nine thousand four hundred and fifty-two.

Eighty-five stations had been occupied for longitude determinations, one hundred and twenty-four for latitude, and eighty-four for azimuths. The topography embraced an area of seventeen thousand square miles, on a general coast line of four thousand miles, and a shore line, measuring the sinuosities, of over forty-two thousand miles.

The hydrography covered an estimated area of forty-six thousand miles. One hundred and ninety-six thousand miles had been run in sounding, six million three hundred and ninety-eight thousand soundings had been made, and more than eight thousand four hundred specimens of bottom obtained.

manuscript maps and charts, two thousand one hundred ighty-one had been constructed; and of engraved maps and sketches, there had been produced four hundred and -three.

triangulation extends from Passamaquoddy Bay on the east boundary of the United States, to Matanzas inlet on ast coast of Florida below St. Augustine, with a single uption of about sixty miles on the coast of South Carolina. Cape Florida it extends over all the line of the Keys to 'ortugas. It embraces also some portion of the western of the peninsula. From St. Marks it is continuous through orge's Sound; it embraces Pensacola harbor, the Perdido ice, Mobile Bay, Mississippi Sound, Lake Borgne and Lake artrain as far as New Orleans. A branch triangulation ds also through Isle au Breton Sound to the mouth of the sippi river. West of the delta it covers most of the coast uisiana and Texas.

the Pacific coast, the survey has been less connected; embraces all the principal harbors, headlands and anges.

e triangulation is on many portions of the coast considera advance of the topography and hydrography. This is ularly the case in Maine, in the Gulf of Mexico and on the west coast. Upon the Maine and Pacific coasts the work ing actively advanced. Energetic reconnoissances have een made in the Gulf, between Mobile and New Orleans, the outbreaking of the war.

e of the most important of the surveys made during the 1862, was that of the Potomac river from near its mouth Georgetown. Connected with this may also be mentioned rtant topographical surveys of the country around Washn.

e survey of the Florida reefs was also energetically pursued g the same period.

e hydrographic operations of this year of which the results probably been most immediately valuable, are those upon ast of North and South Carolina and of Georgia. Hatteras Oregon Inlet, the Neuse river to a point above Newbern, he Harbor of Beaufort with its entrance, were surveyed or veyed so soon as the progress of naval and military operahad opened the way, to the great subsequent advantage of ommanders.

like manner, on the coast of South Carolina, Georgia and da, similar operations were carried on after the occupation rt Royal. Stono inlet and river, Folly and Kiawah rivers, North Edisto river, were resurveyed and sounded out, the nels being found in some of them to be entirely changed.

Parts of St. Helena Sound, Port Royal Sound, Calibogue Sound, Tybee Roads, Wassaw Sound, St. Simon's Sound, and the bar of Fernandina, were also resurveyed, and the shore lines of many of the islands and rivers were traced. All these operations were of essential importance to the success of the national arms upon that coast.

We find in these reports also the usual annual lists of developments and discoveries made in the progress of the survey. Some of these consist in the detection of rocks and shoals previously unknown, lying in frequented waters, and others in bringing to light new and more favorable channels by which the approaches to harbors are improved or the difficulties of navigation diminished. Not less important than these are the discoveries of changes produced by the shifting of sands, introducing dangers which did not previously exist, and rendering it necessary to alter entirely the sailing lines which navigators have been accustomed to follow. The total number of these developments embraced in the general list appended to the latest report, amounts to no less than two hundred and sixteen. Besides the direct benefits to commerce and the national prosperity which flow naturally from the positive information gathered by the coast survey, there are some indirect advantages attending its operations, which are especially important to the interests of science. Of these we find illustrations in the reports before us, in the contributions embraced in the appendices, on the subjects of longitude, Terrestrial Magnetism, the Solar Spots, and the expansibility of metallic bars. The papers on Longitude are by Prof. Peirce, and give the results of his computations from the observations of the Pleiades for the recent period during which the moon's path lay across that group. Some of these observations were made both in this country and in Europe, and serve to determine the errors of the tables, and thus to give additional value to those which were made only in this country. They will also serve to fix the relative longitudes of the places of observation, to correct the places of the stars, and finally to determine the moon's semi-diameter, and "the necessity of having regard to the protuberances of the moon in the complete solution of the problem."

The articles on Magnetism embrace the continuation of the discussion of the Girard College observations, and that of the magnetic survey of the State of Pennsylvania and portions of the adjoining states made by Prof. Bache in 1840 and 1841, and of a partial resurvey of the same region nineteen years later by Assistant Charles A. Schott. Besides these, there is presented the regular biennial publication of results found at twenty-two stations occupied by coast survey parties, for the magnetic *declination*, dip and intensity.

A very interesting part of the discussion of the Girard College observations is that which shows the influence of the moon on the magnetic horizontal force. In the lunar day there is a distinct magnetic tide having two ebbs and flows. The times of maxima are two hours, and of minima seven and a half hours, after the culminations. The influence of the relative positions of the sun and moon on the horizontal magnetic force, though small, is perceptible; and the same is true of the moon's declination changes. When the moon is in perigee, the horizontal magnetic force is diminished, when in apogee, it is increased.

The readers of this Journal are already familiar with many of the subjects here named, through the valuable abstracts of them presented in former volumes, from the pen of the distinguished head of the Survey.

One of the appendices of the report for 1862 contains an abstract of the experiments made for determining the amount and law of expansion by heat of the standard rod used in base measurement, with the results arrived at. These experiments were made by Assistant J. E. Hilgard, assisted by Mr. W. L. Nicholson. The apparatus employed was one of remarkable delicacy, constructed by Mr. Jos. Saxton, furnishing results which will be examined with great interest.

In terminating this brief notice we cannot but express the hope that the experience of the last two years may have the effect to draw the attention of our public men to the importance of extending over the entire surface of the country a survey having the accuracy of that which has been attended with so obvious and great advantages on the coast. One of the most serious of the difficulties which our military commanders have had to contend with in the field, has been their extremely imperfect knowledge of the topographical features of the country in which they were obliged to operate. Much of the delay and uncertainty which have attended our military operations, have been owing to the time expended in the endeavor to acquire this much needed information, and in the doubtful character of a great deal of it after it has been presumably obtained. Had we, at the beginning of this war, been in possession of a topographical survey of the country, like the trigonometrical survey of France, or the ordnance survey of Great Britain, it is by no means improbable that there might have been already saved, in the increased celerity and certainty of our operations, a much larger amount to the treasury of the country, than the whole survey itself could have cost. This is one of those lessons which governments only learn from experience. Let us hope that our present costly experience may not have been thrown away.

Art. XII.—*Proceedings of Learned Societies.*

Royal Society Anniversary.—The President's Address was delivered by Major General* Sabine *on Monday, Nov. 5—as follows.

When I had last the honor of addressing you at the anniversary meeting in 1862, I acquainted you that a communication had been received by your President and Council from the Duke of Newcastle, her Majesty's principal Secretary of State for the Colonies, requesting the opinion of the Royal Society on the scientific importance of the results to be expected from the establishment of a telescope of great optical power at Melbourne, in the colony of Victoria, for the observation of the nebulæ and multiple stars of the Southern Hemisphere. The communication was founded on a despatch from Sir Henry Barkly, K.C.B., Governor of Victoria, soliciting on his own part and on that of the visitors of the Melbourne Observatory, the opinion of the Royal Society on this subject, and also on the most suitable construction of the telescope, both as to the optical part and the mounting, its probable cost, and the time required for its completion. It had happened that in 1853 the Royal Society and the British Association had united in an earnest representation to her Majesty's Government of the scientific importance of establishing in some convenient locality in her Majesty's dominions, from whence the southern nebulæ and multiple stars could be observed, a telescope of the requisite optical power; and in a preparatory correspondence, which was printed at the time, and in which the principal persons interested in such researches had participated, the best form of telescope, its probable cost, and all particulars relating to it, had been largely discussed. The representation thus concurred in by the two principal scientific bodies of the United Kingdom was not successful in securing the desired object; but the correspondence then printed was still fitted to supply in great measure in 1862 the information on which the President and Council could ground their reply. The discussion in 1853 had terminated in the appointment of a committee, consisting of the Earl of Rosse, Dr. Robinson, and Messrs. Lassell and Warren de la Rue, to superintend the construction of the telescope, in the event of the recommendation of the two Societies being favorably received. But, as it was possible that the opinions previously entertained might have been in some degree modified by subsequent consideration or by more recent experience, the correspondence with those gentlemen was reopened, and their replies have formed a second correspondence, which, like the first, has been printed for the information of those Fellows of the Society who take a special interest in the subject. Availing themselves of these valuable communications, the President and Council replied to the Colonial Office by a report dated December 18, 1862. They have been since informed that copies of the report and of the correspondence have been sent to Melbourne for the information of the gentlemen with whom the proposition originated.

It is quite possible that the thoughtful discussions embodied in the correspondence referred to may be found to have a prospective value not

ed to the occasion which has given rise to them. The considera- which apply to a telescope for the observation of the southern læ at Melbourne are no less applicable to one which might be estab- l on a site from whence a great part of the southern nebulæ could be observed (as well as those of our own hemisphere), but enjoying nmense advantage conferred by elevation into the higher and less strata of the atmosphere. Such sites are to be found in the Nil- at elevations of several thousand feet, combining also convenient sibility and proximity to the resources of civilized life. It may be l that at some not distant day the subject will receive the consid- on which it deserves from those who are entrusted with the govern- of that now integral part of the British empire.

iving learnt that a series of pendulum experiments at the principal ns of the Great Russian Arc were in contemplation, I availed lf of an opportunity of informing M. Savitsch, by whom the opera- were to be conducted, that the invariable pendulums which had employed in the English experiments were now in the possession of Royal Society, and, being unemployed, would, I was persuaded, be readily lent by the Society on an application to that effect being . The constants of these instruments, including the coefficient in eduction to a vacuum, having been most carefully determined, they ready, with the clocks and stands belonging to them, for immediate ınd would have the further advantage that experiments made with in Russia would be at once brought into direct connexion with the sh series, extending from 79° 50′ N. to 62° 56′ S. latitude. The nunication was most courteously received and replied to. It ap- d, however, that a detached invariable pendulum had been already ed by the Russian Government from M. Repsold, of Hamburg, er than the English pendulums, for convenience in land transport, vith two knife-edges and two fixed lenses, symmetrically in size and , but one light and the other heavy, and so arranged that the times bration should be the same on either knife-edge in air of the same erature and density. M. Savitsch expressed his desire to bring this ulum in the first instance to Kew, and to secure thereby the con- n of his own with the English series; and where also he would the opportunity of testing the exactness of the correction for ancy by vibrating his pendulum on both its knife-edges in the ım apparatus which is now established at Kew.

is much to be desired that a similar series of pendulum experiments ose about to be undertaken in Russia should be made at the prin- points of the Great Indian Arc; and the steps which are under- l to be in progress in providing new instruments for the verification e astronomical and geodesical operations of the Trigonometrical ey of India, and to give them a still greater extension, would seem esent a most favorable opportunity for the combination of pendulum iments. In such case the pendulums of the Royal Society might ade available with excellent effect.

ıe large size of our printed volumes in the present year gives no orable and, I think, no unfair idea of the present scientific activity ıe Society, for I believe it may be safely said that our Council has

not been less vigilant and cautious than heretofore in the selection of the papers to be printed. Although much care has been given to keeping the expenses of illustration within reasonable bounds, the cost of the Society's publications has been this year unusually high; yet I am glad to be able to state that our whole expenditure within the year has fallen within our income. With your permission, I will briefly advert to a few of the subjects which have occupied the Society's attention in the past year.

The researches of Kirchhoff and Bunsen have rendered it in a high degree probable that we shall be able to obtain much insight into the chemical nature of the atmospheres of the brighter fixed stars by observing the dark lines in their spectra, and comparing them with the bright lines in their spectra of elementary, and perhaps also of compound bodies, in the state of incandescent gas or vapor. The interest of such an inquiry is obvious; but the difficulties involved in it are very great. The quantity of light coming from even such a star as Sirius is so small that, without the use of a powerful telescope, the spectrum obtained would be too faint to bear sufficient enlargement to show properly the fixed lines. The apparent diurnal motion of the stars causes much embarrassment, unless the instrument be mounted equatorially, and furnished with a clock movement. The control of the experiments on incandescent bodies requires a thorough knowledge of chemistry, so as to avoid being misled by impurities in the substances examined, and to be prepared to interpret decompositions or combinations which may take place under unusual circumstances, and which may be manifested only by their effects. Nor can the astronomical and physical parts of the inquiry be well dissociated, so as to be separately undertaken by different individuals; for the most elaborate drawings can hardly convey a faithful idea of the various aspects of the different dark and bright lines, which yet must be borne in mind in instituting a comparison in cases of apparent coincidence. It is fortunate, therefore, that the inquiry has been taken up by two gentlemen working in concert. In a short paper read to the Society on the 26th of last February, and published in the *Proceedings*, Mr. Huggins and Dr. Miller have described and figured the spectra of three of the brighter stars, and this part of the inquiry will doubtless be continued. In a paper since presented to the Society, Mr. Huggins describes the means employed for practically determining with accuracy the positions of any stellar lines which may be observed, with reference to known points of the spectrum, and has given beautiful maps of the spectra of twenty-four of the elementary bodies under the action of the inductive discharge, reserving others for a future communication. When the inquiry is completed, it is possible that we may obtain an amount of knowledge respecting the constitution of those distant heavenly bodies of which we have at present little conception.

Professor Tyndall has given us the fourth of a series of papers upon the relations of gases and vapors to radiant heat. In the course of these inquiries he has shown that the different aëriform bodies, even though colorless, exert very different degrees of absorptive action on the rays of heat; and that certain portions of these heat-rays are more

powerfully absorbed than others, rays from objects at a low temperature being more easily absorbed than those from objects at an elevated temperature. He has also proved that gases radiate as well as absorb; and, in conformity with what is known in the case of solids, that in gaseous media also there is equality in the powers of radiation and absorption. Bodies which exert an absorbent effect in the liquid form preserve it in the gaseous state. If further experiments should confirm Mr. Tyndall's views upon the absorptive action of aqueous vapor upon radiant heat of low intensity, these results must materially modify some of the views hitherto held upon the meteorological relations of aqueous vapor.

The Bakerian Lecture, by Mr. Sorby, is entitled by him 'On the Direct Correlation of Mechanical and Chemical Forces.' In this paper are embodied a series of observations upon the influence of pressure upon the solubility of salts, in which he has obtained results analogous to the change in the freezing point of liquids under pressure. He finds in cases where, as is usual, the volume of the water and the salt is *less* than the volume of the water and the salt separately, that the solubility is *increased* by pressure; but that, in cases where, as when salammoniac is dissolved in water, the bulk of the solution is *greater* than that of the water and salt taken separately, the solubility is *lessened* by a small but measurable amount. On the contrary, salts which expand in crystallizing from solution must, under pressure, overcome mechanical resistance in that change; and, as this resistance is opposed to the force of crystallization, the salt is rendered more soluble. The extent of the influence of pressure, and the mechanical value of the force of crystalline polarity, were found to vary in different salts. Mr. Sorby also indicates the results of the action of salts upon certain carbonates under pressure, and purposes pursuing his researches upon chemical action under pressure. This paper may, therefore, be regarded as forming the first of a series upon a highly interesting and important branch of investigation, for which Mr. Sorby appears to be specially fitted, by combining the needful geological knowledge with the skill in manipulation required in the physical and chemical part of the inquiry.

The examination of the bright lines in the spectra of electric discharges passing through various gases, and between electrodes of various metals, has of late years attracted very general attention. Each elementary gas and each metal show certain well-marked characteristic lines, from the presence or absence of which it is commonly assumed that the presence or absence of the element in question may be inferred. But the question may fairly be asked, Has it been established that these lines depend so absolutely on chemical character that none of them can be common to two or more different bodies? Has it been ascertained that, while the *chemical nature* of the bodies remains unchanged, the lines never vary if the circumstances of mass, density, &c., are changed? What evidence have we that spectra are superposed, so that we observe the full sum of the spectra which the electrodes and the medium would produce separately?

To examine these and similar questions in the only unimpeachable way, that of actual experiment, formed the object of a long and laborious research by Dr. Robinson, the results of which are contained in a

paper in our *Transactions*. In the course of this research, Dr. Robinson had occasion to take careful measures of the positions of all the bright lines visible (and not too weak to measure) in a great number of spectra, those, namely, of the induction discharge passing between electrodes of twenty different metals, as well as graphite, most of which were observed in each of five different gases (including air), and for each gas separately at the atmospheric pressure, and at the low pressure obtained by a good air-pump.

On taking an impartial survey of this great assemblage of experimental facts, Dr. Robinson inclines to the opinion that the origin of the lines is to be referred to some yet undiscovered relation between *matter in general* and the transfer of electric action; and that, while the *places* of the lines are thus determined independently of particular circumstances, the *brightness* of the lines is modified, according to the special properties of the molecules which are present, through a range from great intensity down to a faintness which may elude our most powerful means of observation.

By a discussion of the results of the magnetic observations maintained for several years past at the Kew Observatory with an accuracy previously unattained, and by combining these with the earlier results of the observations at the British colonial observatories, I have been enabled to trace and, as I believe, satisfactorily to establish the existence of an annual variation in the three elements of the earth's magnetism, which has every appearance of being dependent upon the earth's position in her orbit relatively to the sun. Substantiated by the concurrent testimony of observations in both hemispheres, and in parts of the globe most widely distant from each other, this conclusion furnishes an additional evidence of a cosmical magnetic relation subsisting between the earth and other bodies of the solar system, and thus extends the scope and widens the basis of sound induction upon which the permanent relations of magnetical science must rest.

To Dr. Otto Torrell, Professor of Zoology in the University of Lund, we are indebted for a communication of much interest, informing us of the progress made by an expedition, appointed by the Swedish Government at the recommendation of the Royal Academy of Sciences at Stockholm, to execute a survey preliminary to the measurement of an arc of the meridian at Spitzbergen. The objects of the preliminary survey were to ascertain whether suitable angular points for a triangulation could be found from Ross Island at the extreme north, to Hope Island at the extreme south of Spitzbergen, and to determine on a favorable locality for the measurement of a base-line. The result of the first years' exploration has been the selection of stations, on hills of moderate height and easy access from the coast, for nine triangles, shown in the sketch accompanying Dr. Torrell's paper, including Ross Island in the extreme north and extending over about 1° 50′ of the proposed arc of 4½ degrees. A convenient locality has also been found for the base-line. The continuation of the preliminary survey to the extreme southern limit is to be the work of the summer of 1864. The report of the geodesical surveyors has shown that the northern portion presents no impediments which may not be surmounted by courage and

perseverance; and, with regard to the southern portion, the knowledge already acquired is considered to justify the expectation that the result of the second year's exploration will be no less favorable. Should such be the case, it is anticipated that the necessary steps will be taken for carrying into execution the measurement of the arc itself.

I may, perhaps, be permitted to allude for a moment to the peculiar interest with which I must naturally regard the proposed undertaking. The measurement of an arc of the meridian at Spitzbergen is an enterprise which, nearly forty years ago, was a cherished project of my own, which I had planned the means of executing, and which I ardently desired to be permitted to carry out personally. I may well therefore feel a peculiar pleasure in now seeing it renewed under what I regard as yet more promising auspices:—whilst I cannot but be sensible of how little I could have anticipated that I should have had the opportunity, at this distance of time, and from this honorable chair, of congratulating the Swedish Government and Academy upon their undertaking, and of thanking Dr. Torell for having traced its origination to my early proposition.

It is well remarked by Dr. Torell, that the triangulation, should it be proceeded with, will not be the only result of the years of scientific labor at Spitzbergen. There are, indeed, many important investigations for which the geographical circumstances would be eminently favorable. Two such may be specified, for which we may reasonably anticipate, that full opportunity would be afforded, and for which the requisite instruments of precision are neither costly nor cumbersome. One is a more exact determination of the data on which our tables of astronomical refraction are founded. The other is the employment of Cagnoli's method for determining the figure of the earth by occultations of the fixed stars.[1] This last would be tried under circumstances far more favorable than those contemplated by its original proposer—by reason of the high latitude of the northern observer—the greater number of stars in the moon's path, now included in our catalogues, of which a special ephemeris might be made—and the much greater amount of concerted corresponding observations which might now be secured. The advantage peculiar to this mode of determination is, that it is exempt from the influence of local irregularities in the direction and force of gravity which embarrass the results of the measurements of degrees and of pendulum experiments. As a third and thoroughly distinct method of investigation, it seems at least well deserving of a trial.

Swedish naturalists are not likely to undervalue the interest attaching to careful examinations of the constancy or variation of the elevation of land above the sea-level; and I may therefore venture to refer them to a paper in the *Phil. Trans.* for 1824 (Art. xvi), written from Spitzbergen itself in July, 1823, containing the particulars of a barometrical and trigonometrical determination of the height (approximately 1644 English feet) of the well-defined summit of a conspicuous hill in the

[1] Antonio Cagnoli, "Nuovo e sicuro Mezzo per riconoscere la Figura della Terra." Memorie della Societa Italiana, Verona, vol. vi, 1792. An English translation, with notes and an appendix, was printed for private circulation in 1819 by Mr. Francis Baily.

vicinity of Fairhaven. The barometrical comparison was repeated on several days, the barometer on the summit of the hill being stationary, and the observation of the two barometers strictly simultaneous, the stations being visible from each other by a telescope. The height as given by the two methods, barometrical and trigonometrical, was in excellent accord. The hill may be identified with certainty by the plan which accompanies the paper referred to: it is of easy access, and may be remeasured with little difficulty.

It will be remembered that a few years ago the attention of the Royal Society was called by the Foreign Office to the circumstance of several glass bottles with closed necks having been found on the shores of the west coast of Nova Zembla, leading to a conjecture that they might afford some clue to the discovery of the missing ships of Sir John Franklin's expedition. The inquiries instituted by the Royal Society traced the bottles in question to a recent manufacture in Norway, where they are used as floats to the fishing-nets employed on that coast. These floats, accidentally separated from the nets, had been carried by the stream-current which sets along the Norwegian coast round the the North Cape, and thus afforded evidence of the prolongation of the current of Nova Zembla. The Swedish expedition in the course of its summer exploration found on the northern coast of Spitzbergen several more of these bottle-floats, some of which even bore Norwegian marks and names, supplying evidence, of considerable geographical interest, of the extension of the Norwegian stream-current to Spitzbergen, either by a circuitous course past the shores of Nova Zembla, or by a more direct offshoot of which no previous knowledge existed. It is thus that step by step we improve our knowledge of the currents which convey the waters of the more temperate regions to the Polar seas, and produce effects which are traceable in many departments of physical geography.

The application of gun-cotton to warlike purposes and engineering operations, and the recent improvements in its manufacture, have been the subject of a report prepared by a joint committee of the chemical and mechanical sections of the British Association, consisting chiefly of Fellows of the Royal Society. The report was presented at the meeting in Newcastle in September last, and is now in the press. The committee had the advantage of personal communication with General von Lenk, of the Imperial Austrian artillery, the inventor of the system of preparation and adaptation by which gun-cotton has been made practically available for warlike purposes in the Austrian service. On the invitation of the Committee, and with the very liberal permission of the Emperor of Austria, General von Lenk visited England for the purpose of thoroughly explaining his system; and we have in the report of the Committee the information, thus gained directly from the fountain-head, of the results of his experience in the course of trials extending over many years; together with additional investigations by individual members of the Committee.

The advantages which are claimed for gun-cotton over gun-powder for ordnance purposes and mining operations are so many and so important as to call imperatively for the fullest investigation. Such an inquiry, however, in its complete sense, is both beyond and beside the scope and purposes of a purely scientific body; and the British Association have

done well—whilst reappointing the Committee to complete certain experiments which they had devised, with the view of clearing up some scientific points which are still more or less obscure—in pressing on the attention of her Majesty's Government the expediency of instituting under its own auspices a full and searching inquiry into the possible applications of gun-cotton in the public service.

The absence of smoke, and the entire freedom from the fouling of the gun, are points of great moment in promoting the rapidity of fire and the accuracy of aim of guns employed in casemates or in the between-decks of ships of war; to these we must add the innocuous character of the products of combustion in comparison with those of gun-powder, and the far inferior heat imparted to the gun itself by repeated and rapid discharges. With equal projectile effects, the weight of the charge of gun-cotton is but one-third of that of gun-powder: the recoil is stated to be reduced in the proportion of 2 to 3, and the length of the gun itself to admit of a diminution of nearly one-third. These conclusions are based on the evidence of long and apparently very carefully conducted courses of experiment in the imperial factory in the neighborhood of Vienna. The results appear to be especially deserving the attention of those who are engaged in the important problems of facilitating the employment of guns of large calibre and of great projectile force in the broadsides of our line-of-battle ships, and in reducing, as far as may be possible, the dimensions of the ports.

In the varied applications of explosive force in military or civil engineering, the details of many experiments which bear on this branch of the inquiry are stated in the report of the committee, and appear to be highly worthy of consideration and of further experiment.

It cannot be said that the advantages now claimed for gun-cotton are altogether a novel subject of discussion in this country. When the material was first introduced by Schönbein in 1846, its distinctive qualities in comparison with gunpowder were recognized, although at that period they were far less well ascertained by experiment than they are at present. To the employment of gun-cotton as then known there was, however, a fatal drawback in its liability to spontaneous combustion. The elaborate experiments of General von Lenk have shown that this liability was due to imperfection in its preparation, and ceases altogether when suitable processes are adopted in its manufacture. Perfect gun-cotton is a definite chemical compound; and certain processes for the removal of all extraneous matter and of every trace of free acid are absolutely indispensable. But, when thus prepared, it appears to be no longer liable to spontaneous combustion: it can be transported from place to place with perfect security, or be stored for any length of time without danger of deterioration. It is not impaired by damp; and may be submerged without injury, its original qualities returning unchanged on its being dried in the open air and in ordinary temperatures.

A scarcely less important point towards the utilization of gun-cotton, and the safety with which it may be employed in gunnery, is the power of modifying and regulating its explosive energy at pleasure, by means of variations in the mechanical structure of the cartridge, and in the relative size of the chamber in which it is fired.

The experiments made by the Austrian Artillery Commission, as well as those for blasting and mining, were conducted on a very large scale; with small arms the trials appear to have been comparatively few.

There can be no hesitation in assenting to and accepting the concluding sentence of the Committee's report. 'The subject has neither chemically nor mechanically received that thorough investigation that it deserves. There remain many exact measures still to be made, and many important data to be obtained. The phenomena attending the explosion of both gun-cotton and gunpowder have to be investigated, both as to the temperatures generated in the act of explosion, and the nature of the compounds which result from them, under circumstances strictly analogous to those which occur in artillery practice.'

I proceed to announce the awards which the Council has made of the Medals in the present year; and to state the grounds upon which these awards have been made.

The Copley Medal has been awarded to the Rev. Adam Sedgwick, for his observations and discoveries in the Geology of the Paleozoic Series of Rocks, and more especially for his determination of the characters of the Devonian System, by observations of the order and superposition of the Killas Rocks and their Fossils in Devonshire.

Mr. Sedgwick was appointed Woodwardian Professor of Geology in the University of Cambridge in the year 1818, since which time, up to a recent period, comprising an interval of upwards of forty years, he has devoted himself to geological researches with an ability, a persistent zeal, and untiring perseverance, which place him amongst the foremost of those eminent men by whose genius, sagacity and labors the science of geology has attained its present high position. To duly appreciate his earlier work as a geological observer and reasoner, we must recall to recollection the comparative ignorance which prevailed forty or fifty years ago, to the dispersion of which his labors have so largely contributed. Geology was then beset by wild and untenable speculations on the one hand, whilst on the other even its most calm and rational theories were received by many with distrust or with ridicule, and by others with aversion, as likely to interfere with those convictions on which the best hopes of man repose.

Under such circumstances geology needed the support and open advocacy of men who, by their intellect and acquirements, and by the respect attached to their individual characters, their profession, or social position, might be able on the one hand to repress wild fancies, and on the other to rebut the unfounded assertions of those who opposed the discussion of scientific truth. Such a man was Professor Sedgwick, and such was the influence he exerted. It may be well to make this allusion on an occasion like the present, because it often happens, not unnaturally, that those who are most occupied with the questions of the day in an advancing science retain but an imperfect recollection of the obligations due to those who laid the first foundations of our subsequent knowledge.

More than forty years have passed since Professor Sedgwick began those researches among the older rocks of England which it became the main purpose of his life to complete. In 1822 was begun that full and accurate survey of the Magnesian Limestone of the North of England

which to this day holds its high place in the estimation of geologists as the foundation of our knowledge of this important class of deposits, whether we regard their origin, form of deposition, peculiarities of structure, or organic contents.

Contemporaneously with this excellent work, he examined the whin sill of Upper Teesdale, showed its claims to be treated as a rock of fusion, and discussed the perplexed question of its origin.

Advancing to one of the great problems which occupied his thoughts for many years, he combined in 1831 the observations of the older rocks of the Lake mountains which he had commenced in 1822, and added a special memoir on the great dislocations by which they are sharply defined and separated from the Pennine chain of Yorkshire. Memoirs followed in quick succession on the New Red Sandstone of the Vale of Eden; on the stratified and unstratified rocks of the Cumbrian Mountains, and on the limestone and granite veins near Shap. Thus, thirty years since, before the names of Cambrian and Silurian were ever heard, under which we now thankfully class the strata of the English Lakes, those rocks had been vigorously assailed and brought into a lucid order and system, which is to this day unchanged; though by the same hands which laid the foundations many important additions have been made, one of signal value in 1851—the lower Paleozoic rocks at the base of the Carboniferous chain between Ravenstondale and Ribblesdale. Perhaps no district in the world affords an example of one man's researches begun so early, continued so long, and ending so successfully. By these persevering efforts, the geology of the lake district came out into the light; and there is no doubt, and can be no hesitation in ascribing to them the undivided honor of the first unrolling of the long series of deposits which constitute the oldest groups of British fossiliferous rocks.

Still more complete, however, was the success of that work which was undertaken immediately afterwards on the coeval rocks of Wales; by which Professor Sedgwick and Sir Roderick Murchison, toiling in separate districts, unravelled the intricate relations of those ancient rocks, and determined the main features of the successive groups of ancient life which they enclose. These labors began in 1831–32, and in 1835 the two great explorers had advanced so far in their research as to present a united memoir to the British Association in Dublin, showing the progress each had made in the establishment of the Cambrian and Silurian systems, as they were then called; Professor Sedgwick taking the former, and Sir Roderick Murchison the latter for his special field of study.

In 1843 Professor Sedgwick produced two memoirs on the structure of what he then termed the Protozoic rocks of North Wales. Many excellent sections were given in detail in these memoirs; those exhibiting the structure of the western part of the district about Carnarvonshire being principally taken from his observations in 1831–32, while the more detailed sections of the eastern part were from those of 1842–43. These two papers gave the complete outline or framework, as it were, of the geological structure of this intricate region. In several subsequent years he continued to fill up this outline with further details, observed almost entirely by himself, giving numerous general and local sections, by which he determined the dip and strike of the beds, normal and abnor-

mal, and all the great anticlinal and sinclinal lines on which the fundamental framework depends.

Further and still minuter details were subsequently given, as was to be expected, by the government surveyors; but the general arrangement, finally recognised on the map of the survey, is essentially the same as that previously worked out by his unaided labors.

It was a principle always advocated by Professor Sedgwick, that the geological structure of a complicated district could never be accurately determined by fossils alone without a detailed examination of its stratification. He always proceeded on this principle; nor (from the paucity of organic remains) would it have been possible on any other principle to have determined the real geological character of those older districts which he investigated so successfully. His arrangement and nomenclature of the Cambrian rocks in North Wales (the Lower Silurians of Sir Roderick Murchison) are given in his 'Synopsis of the Classification of the British Paleozoic Rocks,' 1855. It possesses the weight which must always be recognised as appertaining to the authority of the geologist who, by his own labors, first solved the great problem of the physical structure of the district.

There are other important memoirs of Professor Sedgwick's of which time forbids more than a very passing notice. The memoir 'On the Structure of large Mineral Masses,' published in 1831, was the first, and remains to this day the best descriptive paper which has yet appeared on joints, planes of cleavage, nodular concretions, &c.

Always attentive to the purpose of preparing a complete and general classification of the Paleozoic strata, Professor Sedgwick at an early period in his career printed a memoir 'On the Physical Structure of the Older Strata of Devon and Cornwall;' and another 'On the Physical Structure of the Serpentine District of the Lizard.' Of later date are several papers written by him, conjointly with Sir Roderick Murchison, respecting the Devonian system. The principal of these, published in 1840, comprised the work of several previous years, and made known the true nature of the *Culm Beds* of North Devon, as belonging to the Carboniferous series, and their position in a trough of the subjacent rocks, which rocks, on account of their position and their organic contents, were concluded to belong to the Devonian, or Old Red Sandstone period, a conclusion which was at first controverted, but was ultimately admitted. In another memoir by the same authors in 1828, they conclude that the coarse old red conglomerate along the north-western coast of Scotland and in Caithness is of about the same age as the Old Red Sandstone of South Wales and Herefordshire, and therefore of the Devonian period. They also published in 1840 an account of their general observations on the Paleozoic formations of Belgium and the banks of the Rhine, the results of which were considered to harmonize with those derived from other localities. Finally, we may notice another joint memoir by these authors in 1830, 'On the Structure of the Eastern Alps,' which, however, had no immediate relation to the researches on the Paleozoic formations.

It will be observed that the memoirs which have been noticed are for the most part pervaded by a certain unity of purpose. The investigations were not on points of merely local interest, but were essential for

the elucidation of the geological history of our planet during those early periods of which the records are most difficult to unfold. Few persons, perhaps, can have an adequate idea of the difficulties he had to contend with when he first entered North Wales as a geologist. Geologically speaking, it was a *terra incognita* of which he undertook to read the geological history before any one had deciphered the characters in which it is written. Moreover, besides the indistinctness and complexity of the stratification, and the obscurity which then prevailed as to the distinction between planes of stratification and planes of cleavage, there was also the difficulty of what may be called 'mountain geometry'—that geometry by which we unite in imagination lines and surfaces observed in one part of a complicated mountain or district with those in another, so as to form a distinct geometrical conception of the arrangement of the intervening masses. This is not an ordinary power; but Mr. Sedgwick's early mathematical education was favorable to the cultivation of it. We think it extremely doubtful whether any other British geologist forty years ago could have undertaken, with a fair chance of success, the great and difficult work which he accomplished.

Such are the direct and legitimate claims of Professor Sedgwick to the honor conferred upon him by the award of the Copley Medal. But there are also other claims, less direct, but which it would be wrong to pass altogether unnoticed. It is not only by written documents that knowledge and a taste for its acquirement are disseminated; and those who have had the good fortune to attend Professor Sedgwick's lectures, or may have enjoyed social intercourse with him, will testify to the charm and interest he frequently gives to geology by the happy mixture of playful elucidation of the subject with the graver and eloquent exposition of its higher principles and objects."

The Copley Medal was then presented with the following address:—

"Professor Sedgwick,—Accept this medal, the highest honor which it is in the power of the Royal Society to confer, in testimony of our appreciation of the importance of the researches which have occupied so large a portion of your life, and which have placed you in the foremost rank of those eminent men by whose genius and labors geology has attained its present high position in our country."

The Council has awarded a royal medal to the Rev. Miles Joseph Berkeley for his researches in Cryptogamic Botany, especially Mycology.

Mr. Berkeley's labors as a cryptogamic botanist for upwards of thirty-five years, during which they have been more especially devoted to that extensive and most difficult order of plants the fungi, have rendered him, in the opinion of the botanical members of the Council, by far the most eminent living author in that department. These labors have consisted in large measure of the most arduous and delicate microscopic investigation. Besides papers in various journals on fungi from all parts of the globe, and in particular an early and admirable memoir on British fungi, the volume entitled 'Introduction to Cryptogamic Botany,' published in 1857, is one which especially deserves to be noticed here. It is a work which he alone was qualified to write. It is full of sagacious remarks and reasoning; and particular praise is due to the special and conscientious care bestowed on the verification of every part, however minute

and difficult, upon which its broad generalizations are founded. Mr. Berkeley's merits are not confined to description or classification; there are facts of the highest significance which he has been the first to indicate, and which in many cases he has also proved by observation and by experiments. We refer to his observations on the development of the reproductive bodies of the three orders of Thallogens (Algæ, Lichens, and Fungi), and on the conversion under peculiar conditions of certain forms of their fruit into others; to the exact determination of the relations, and sometimes of the absolute specific identity of various forms of fungi previously referred to different tribes; and to the recognition, in many species and genera, of a diversity of methods of reproduction in giving origin to parallel series of forms. As intimately connected with the life-history of fungi, the intricate subject of vegetable pathology has been greatly elucidated by him; and he is, indeed, the one British authority in this department. His intimate acquaintance with vegetable tissues, and with the effects of external agents—such as climate, soil, exposure, &c.—has enabled him to refer many maladies to their source, and to propose methods, which in some cases have proved successful, of averting, checking, and even curing diseases in some of our most valuable crops. In this line of research he has also demonstrated, on the one hand, that many so-called epiphytal and parasitic fungi are nothing but morbid conditions of the tissues of the plant; on the other hand, that microscopic fungi lurk and produce the most disastrous results where their presence had been least suspected.

Addressing the Rev. M. Berkeley, the President said:—

"MR. BERKELEY,—I present you with this medal in testimony of the high opinion which the botanical members of the Council of the Royal Society entertain of your researches in cryptogamic botany, especially mycology, which, in their judgment, entitle you to be regarded as the most eminent living author in that department of science."

The Council has awarded a royal medal to John Peter Gassiot, Esq., for his researches on the Voltaic Battery and Current, and on the Discharge of Electricity through Attenuated Media. These contributions, most of which are recorded in our *Transactions*, are of high value, and in some respects peculiar. Their experimental part has been conducted on a scale of magnitude and power unmatched since the days of Davy and of Children, with apparatus of the highest perfection, and with consummate dexterity and skill; and the discussion and interpretation of the facts observed are characterized by sound theory and sober judgment. It would trespass too much on your time were I to give a detailed account of them, and I shall only select a few which are examples of what Bacon has called 'Instantiæ Crucis'—such as, when the mind is undecided between several paths, point out the true one.

1. The first decides a question which was long debated with great vehemence, whether the energy of the voltaic battery arises from the contact of its metals, or from chemical action. The first of these opinions was mainly supported by the fact that, when two dissimilar metals are made to touch, they show signs of opposite electricities when separated. Mr. Gassiot showed in 1844 that the same occurs when the metals *are separated* by a thin stratum of air without having been in previous *contact*.

2. The identity of voltaic with frictional electricity was denied by many, because it gave no spark through an interval of air. Davy had, indeed, asserted the contrary in his 'Elements of Chemical Philosophy;' but his statement seems to have been doubted or unheeded. Mr. Gassiot, in the *Transactions* for 1844, has put the fact beyond dispute; he showed that, by increasing the number of cells and carefully insulating them, sparks can be obtained even with the feeblest elements. With 3520 cells, zinc and copper excited with rain-water, he obtained sparks in rapid succession through $\frac{1}{50}$th of an inch; and a little later added to this a fact of still higher significance, that, by exalting the chemical action in the cells, the same or even greater effect could be produced by a much smaller series. The battery of 500 Grove's cells, which was constructed for these experiments, is probably in some respects, the most powerful that was ever made.

3. The currents produced by electric or magnetic induction are of the highest interest, and the employment of them as a source of electric power, is almost daily enriching physical science with precious results. In this new field Mr. Gassiot has been one of the most successful explorers. So early as 1839 he showed that the induction-current gives a real spark, and he found that in the flame of a spirit-lamp it could strike at a distance of $\frac{3}{4}$ths of an inch.

4. The splendid phenomena produced by the discharge of the induction-current through rarefied gases or vapors are well known; in particular the stratification of the light. The cause of this is not yet fully understood, but Mr. Gassiot has made some very important additions to our knowledge of it in the Bakerian Lecture for 1858, and his subsequent communications to the Society. Among these may be named his explanation of the occasionally reversed curvature of the strata, and his discovery of the reciprocating discharge, which, seeming single, is composed of two opposite in direction, but detected by the different action of a magnet on each of them—a beautiful test, which is of wide application in such researches. Again, the Torricellian vacuum which he used at first, even when absolutely free from air, contains mercurial vapor: by applying to his tubes a potent freezing mixture he found that as this vapor condensed the strata vanished, the light and transmission of electricity decreased, till at a very low temperature both ceased entirely. It follows from this that a perfect vacuum does not conduct—a fact of cosmical importance, which had been surmised before, but not proved; and the desire of verifying this discovery led him to a means of far higher rarefaction. A tube containing a piece of fused hydrate of potassa is filled with dry carbonic acid, exhausted to the limit of the air-pump's power, and sealed; then, by heating the potassa, the residual carbonic acid is mostly, or even totally, absorbed. Vessels so exhausted, though still containing vapor of potassa, and, perhaps, of water, have a better vacuum than had been previously obtained, and often cease to conduct till a little of the alkali is vaporized by heating them, and the gradual progress of the exhaustion gives a wide range of observation.

5. The current of an induction machine is necessarily intermittent, and it has been supposed that the strata are in some way caused by the intermittence, and are possibly connected with the mode of action of the

contact-breaker. Mr. Gassiot has, however, shown that they are perfectly developed in the discharge of an extended voltaic battery through exhausted tubes. The large water-battery already mentioned shows them in great beauty; the discharge, however, is still intermittent.

6. The same appearance is exhibited by a Grove's battery of 400 well-insulated cells; but in this case a new and remarkable phenomenon presents itself. At first the discharge resembles that obtained from the water-battery, and is, like it, intermittent; but, *suddenly*, it changes its character from intermittent to continuous (so far, at least, as can be decided by a revolving mirror), and everything indicates that we have now the true voltaic arc. The discharge is now of dazzling brilliancy, *and is stratified as before*, whence it appears that strata are capable of being produced by the true arc discharge.

7. This change is accompanied by a remarkable alteration in the heating of the two electrodes. Mr. Gassiot had previously shown that, in the ordinary voltaic arc, formed in the air of the usual pressure, the *positive* electrode is that which is the more heated, whilst in the discharge of an induction machine, whether sent through air at the ordinary pressure between electrodes of thin wire, or through an exhausted tube, it is the *negative*. The discharge through the large Grove's battery, so long as it was intermittent, agreed with the induction discharge in this character as in others, that the *negative* electrode was that which became heated; but, when the discharge suddenly and spontaneously passed from the intermittent to continuous, the previously heated negative electrode became cool, and the positive was intensely heated.

These brief references will suffice to show what a high place Mr. Gassiot holds amongst those who are investigating this new track, which promises such great advance in our knowledge of those molecular forces in the study of which all physical science must ultimately centre. I may be permitted to add, that in his whole career he has sought not his own fame, but the advancement of science; he has rejoiced as much in the discoveries of others as in his own, and aided them by every appliance in his power. I cannot refrain from mentioning a recent instance in which this liberal and unselfish spirit has been strikingly exhibited. He has had executed a grand spectroscope, furnished with no less than nine faultless prisms, a design in which he has been ably seconded by the skill of the optician Mr. Browning, to whom the construction was entrusted. This magnificent instrument he has placed at the disposal of any Fellow of the Society who may happen to be engaged in researches requiring the use of such powerful apparatus. The instrument is at present at the Kew Observatory, where it is in contemplation to undertake the construction of a highly elaborate map of the spectrum.

Mr. Gassiot is still pursuing his electrical researches, and we may be assured that he will feel this acknowledgment of his labors by the Royal Society not merely as a recompense for that he has accomplished, but as an obligation to continued exertion and new discoveries."

The medal was then handed to Mr. Gassiot, with the following remarks:—

"MR. GASSIOT,—You will receive this medal as a mark of the deep interest which the Royal Society takes in the investigations in which you

are engaged, and of the high value which it attaches to the results with which you have already enriched our transactions.

These are the grounds on which the medal has been awarded to you by the Council; but it may be permitted to me to express the hope that you will also associate with it—as it is impossible that we should not do—the Society's recognition of the generous and kindly spirit which has manifested itself, as elsewhere, so also in all your pursuit of science, of which one memorial amongst others will remain in future times connected with the Society—in the establishment of the Scientific Relief Fund."—*The Reader, Dec.* 5, 1863.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS.

1. *Electrical properties of Pyroxiline-paper and Gun-cotton.*—Prof. JOHN JOHNSTON, of Wesleyan University, Ct., has called my attention to a remarkable power in pyroxiline-paper of producing positive electrical excitement in sulphur, sealing wax, &c. His note is as follows:

Wesleyan University, Middletown, Dec. 24, 1863.

Prof. SILLIMAN—*Dear Sir:*—We are told by writers on electricity that sulphur by friction with all other substances becomes *negatively* excited; as cat's fur, on the other extreme, by friction with all other substances becomes excited *positively*. But a few days ago I made the discovery that sulphur by friction with paper pyroxiline (I will call it) is excited with positive electricity, as are also sealing wax, amber, &c. The paper is prepared in the same manner as gun-cotton, which would also in all probability be found to possess the same property.

Inclosed please find some of the paper for trial. It was prepared by my son, M. M. Johnston.

Perhaps you will think the matter of sufficient importance to make a note of it in the Journal of Science. Respectfully yours,

JOHN JOHNSTON.

I have repeated and confirmed Prof. Johnston's experiment, extending it to gun-cotton. I find as he suggests that the latter substance produces the same excitement of positive electricity which is produced by the pyroxiline-paper. The most energetic effects are produced when vulcanized india rubber is the electric. The opposite effects in this substance produced by flannel and the gun-cotton or pyroxiline-paper are very striking, and will form a good lecture room illustration. These substances also produce powerful positive excitement in glass. It is difficult from the use of pith balls alone to determine which produces the most powerful positive excitement, glass or hard rubber, when excited by gun-cotton or pyroxiline-paper. This seeming anomaly, confounding our ordinary means of discrimination in cases of electrical excitement, demands further investigation. It would appear that of negative electrics yet observed, these azotized species of cellulose are the most remarkable—in comparison with which the most highly negative electrics hitherto known become positive. B. S., JR.

December 25, 1863.

4. *On the wave lengths of certain spectral lines.*—J. MÜLLER has measured the wave lengths of several interesting lines by means of the diffraction spectrum. The results obtained were as follows:

For the yellow sodium line, Naα, $\lambda = 0\cdot0005918^{mm}$.
For the red lithium line, Liα, $\lambda = 0\cdot0006763^{mm}$.
For the blue strontium line, Srδ, $\lambda = 0\cdot0004631^{mm}$.
For the green thallium line, Thα, $\lambda = 0\cdot0005348^{mm}$.

Pogg. Ann., cxviii, 641. W. G.

II. CHEMISTRY.

1. *On a new metallic oxyd.*—BAHR claims to have discovered in a mineral from Rönsholm, an island near Stockholm, a new metal which he calls Wasium, from the royal family of Wasa. The mineral itself—Wasit—resembles orthite and was found to contain silica, alumina, oxyd of iron, cerium, didymium, lime, manganese, magnesia and alkali, together with a trace of uranium, a tantalic acid and perhaps thoria. About one per cent of the new oxyd is present. As obtained by the ignition of the nitrate it is a brownish sandy powder of density 3·726. Before the blowpipe it gives with borax in both flames a clear and colorless glass which readily becomes milk-white by flaming. With the phosphate it gives a clear and colorless glass bead which does not become opaque on flaming. The compounds of Wasium give no spectrum in the gas flame. When the oxyd is treated with strong nitric acid in a porcelain dish it becomes yellowish but does not dissolve. By evaporation on a sand bath it assumes the appearance of thick groats with a warm tint, gradually it becomes lilac-colored, then darker and bluish brown, and on the border appears a ring of a brilliant brown varnish, which becomes broader till the mass assumes a gummy appearance. Water converts it into a white opaque substance which gives an emulsion like groats; more water easily dissolves it, but a few drops of nitric acid produce the appearance of groats again. The author considers this reaction with nitric acid as characteristic of the new metallic oxyd. Solutions of the oxyd were precipitated by ammonia, the precipitate being insoluble in caustic potash but soluble in carbonate of ammonia. The oxyd was also precipitated from quite acid solutions by oxalic acid and its salts. It is to be hoped that a more appropriate name will be found for the new metal, if indeed,—which we cannot but regard as rather doubtful—a new metallic oxyd actually occurs in the minerals mentioned by Bahr—Wasite, Norwegian orthite and gadolinite from Ytterby.—*Pogg. Ann.*, cxix, 572. W. G.

[*Note*, Dec. 31.—Since the above was in type, we find in *Comptes Rendus* (lvii, 1740,) a note from our esteemed correspondent, Prof. Nicklès, shewing satisfactorily that the so-called wasium of Bahr is nothing more than yttrium containing a little of its congeners didymium, or terbium. This conclusion Prof. N. justifies by a tabular comparison of the properties of the supposed new metal with those on which the autonomy of yttrium rest. The rose color of the nitrate of wasia is precisely that of nitrate of yttria, when, according to Mosander, this salt contains didymium, or, according to Berzelius, terbium. Klaproth's nitrate of yttria furnishes the same gelatinous precipitate on evaporation of its watery solution which Bahr insists on as characteristic of the new metallic oxyd.—S.]

2. *On solid arseniuret of hydrogen.*—WIEDERHOLD has described and analyzed the solid compound of arsenic and hydrogen long known to chemists but hitherto very imperfectly studied. The author obtains this substance by the action of chlorhydric acid upon an alloy of arsenic and zinc, obtained by fusing the two metals together at a high temperature in the proportion of 1 part of arsenic to 5 of zinc. The arseniuret is a light, very voluminous powder of a reddish-brown color, strongly resembling peroxyd of lead. It is insoluble in water, alcohol, ether, bisulphid of carbon and petroleum. Its formula is As_2H; at 200° C. it is completely resolved into pure hydrogen and arsenic. Ignited in the air the arseniuret burns with a yellow flame like tinder, leaving as a residue arsenous acid, metallic arsenic, and a small quantity of black matter which may be a new oxyd of arsenic. In fusing nitric acid the compound burns with evolution of light and forms arsenous and arsenic acids. A trace of the powder taken into the nostrils in inspiration produce a slight inflammation of the mucous membrane with swelling of the lower part of the nose. Its poisonous character may be readily inferred.—*Pogg. Ann.*, cxviii, 615. W. G.

3. *On the crystalline form of sulphate of thallium.*—VICTOR VON LANG has measured crystals of sulphate of thallium which are isomorphous with sulphate of potassium. The observed rhombic faces were 100, 010, 110, 210, 101, 111. The ratio of the axes is for

$$ThSO_4, \quad a:b:c=1:0{\cdot}7319:0{\cdot}5539$$

and for

$$KSO_4, \quad a:b:c=1:0{\cdot}7464:0{\cdot}5727$$

The surfaces reflected very well and exhibited an adamantoid lustre, probably in consequence of the large quantity of thallium in the salt. The position of the optical axes of elasticity corresponded with that in sulphate of ammonium but not with that in sulphate of potassium.—*Pogg. Ann.*, cxviii, 630. W. G.

4. *On a crystallized hydrate of soda.*—HARMS has obtained a well crystallized and definite hydrate of soda by exposing a solution of caustic soda of density 1·385 to a temperature of 0° C. The crystals are often very large, have a glassy lustre and are perfectly transparent and colorless; they fuse at 6° C. and yield a solution of density of 1·405. As the author states that the crystals may be obtained very pure even from solutions which contain sulphate and chlorid of sodium, it seems probable that they will afford a ready means of obtaining pure soda solutions for laboratory use. The formula of the crystallized hydrate is $NaO+8HO$; by long standing over sulphuric acid the compound loses four equivalents of water. The crystals were measured by G. Rose and found to be oblique rhombic.—*Pogg. Ann.*, cxix, 170. W. G.

5. *On the constitution of Columbite.*—H. ROSE has published an extended discussion of the minerals which contain hyponiobic acid. As specially interesting to chemists we note simply the fact that in pure and undecomposed varieties the ratio of the oxygen in the acid to that in the bases is as 3 to 1, so that pure columbites may be regarded as mixtures of Nb_2O_3 FeO with Nb_2O_3 MnO. Rose calls attention to the isomorphism of columbite and wolfram, and remarks further that the observations of Nordenskiöld, and later of himself, go to prove that hyponiobic and tungstic acids are isomorphous in the uncombined state, so

that we have crystallographically $Nb_2O_3=WO_3$. A reduction of the equivalent of tungsten so as to make tungstic acid W_2O_3 does not appear to be admissable.—*Pogg. Ann.*, cxviii, 406. W. G.

[*Note.*—Since niobic acid, NbO_2, unquestionably belongs to the same natural group as silicic and titanic acids, SiO_2 and TiO_2, and since there is good reason to believe that the true equivalents of these acids are Si_2O_4 and Ti_2O_4, the formula of niobic acid will become Nb_2O_4, and if with many chemists we consider silicon, titanium, niobium and certain other elements as tetratomic, we shall have for the acids SiO_4, TiO_4, NbO_4, &c. Hyponiobic acid must then be written NbO_3 and its isomorphism with WO_3 will appear natural. If oxygen be taken as 16 instead of 8, we have $Nb_2\Theta_3=W_2\Theta_3$ as crystallographic equality. The vapor densities of $NbCl_2$ and $TnCl_2$ correspond to 2 vols., and though the assumption that the molecules of all compounds correspond to 4 vols. is very far from being a safe one, we may still consider this fact as some argument for writing the chlorids $NbCl_4$ and $TnCl_4$. On the other hand Marignac has recently shown that the oxy-fluo-tungstates are isomorphous with the fluo titanates, since we have $TiF_2\ CuF=WO_4Cu+WF_4Cu$. Marignac writes this equality $Ti_2F_6Cu_2=W_2\Theta_2F_4Cu_2$ or $TF_6\Theta u=W\Theta_2F_4Cu$, and assumes that $\Theta_2=F_2$. This obliges us to admit that in this compound $Ti_2=W_2$, while the view, which we have taken above requires $Nb_2=Ti_2=W$, since $Nb=Ti$ in combination. The proper mode of reconciling these differences must be left for a further accumulation of well ascertained cases of isomorphism.—W. G.]

6. *On alloys containing tungsten.*—CARON has instituted a series of experiments by order of the French Minister of War to determine the influence produced by tungsten upon the qualities of bronze, cast iron and steel. The only French mine from which tungsten is obtained in quantity belongs to M. Dubreuil, and is situated at Puy-les-Viques near St. Leonard, in the department of the Haute Vienne. The wolfram is here pulverized and roasted to separate sulphur and arsenic. In this state it could be sold at 2f·60 the kilogramme, but it is better to reduce it to the metallic state by heating with enough carbon to reduce the metals. The crude tungsten contains iron, manganese, and carbon and is now sold at 3f·75 the kilogramme, a price which will probably be still farther reduced. Tungsten as thus prepared was found incapable of forming true alloys with copper, tin, and gun-metal, the latter becoming less homogeneous and less tenacious than ordinary bronze, although harder. The addition of tungsten to cast-iron was found on the contrary to increase both the hardness and tenacity in about the same ratio with the quantity of tungsten added. Even a small per-centage, not exceeding one per cent of tungsten, was found to exert a marked influence, the grain of the iron becoming regular, fine and grayish, and the fracture showing great homogeneity. The addition of tungsten to steel was found always to increase both its hardness and its tenacity. The alloy exhibits a peculiar fracture with a brilliant lustre so that tungsten steel is easily recognized by a practised eye. Poor steel requires more tungsten than steel of good quality. A good cement steel alloyed with 5 per 100 of tungsten gave a steel of excessive hardness which, however, forged very well, though it required much more force than ordinary steel. After tempering, it ac-

quired a hardness comparable only to that of the hard white cast-iron. A gun barrel made of steel which on analysis proved to contain tungsten, withstood the explosion of a charge of powder $0^{m}\cdot6$ in length and weighing 150 grammes, with 5 balls of lead weighing 135 grammes. The author succeeded in obtaining a steel of similar quality by fusing together in an earthen crucible at a very high temperature, 200 grammes of highly carburetted steel, 800 grammes of good iron and 20 grammes of tungsten. In conclusion Caron confidently recommends the employment of tungsten to improve the qualities of steel, and shows that with tungsten at $3^{f}\cdot70$ the kilogramme, the price of steel would be increased by only 7 or 8 francs the 100 kilogrammes.—*Ann. de Chimie*, lxviii, 143. W. G.

[See p. 127 for further notice of titanium in pig iron.]

7. *On a new series of metallic oxyds.*—H. Rose has discovered a class of oxyds which contain four equivalents of metal to one of oxygen. The type of this class of compounds is an oxyd of copper which has the formula Cu_4O. When a solution of sulphate of copper is added to an excess of a very dilute solution of protochlorid of tin in caustic alkali, a hydrate of protoxyd of copper is precipitated, which after a short time becomes yellow, and on shaking passes into olive-green; after a time this in turn changes color and finally becomes reduced to metallic copper. The green oxyd cannot be obtained in a state of purity without great difficulty, owing to its tendency to oxydize and also to the difficulty of removing the last traces of tin. Rose has, however, succeeded in establishing its constitution beyond a doubt. Dilute sulphuric acid decomposes the oxyd into one atom of sulphate of copper and three atoms of metallic copper. Dilute chlorhydric acid forms at first a dark-colored substance (perhaps Cu_4Cl), but metallic copper and the white subchlorid are speedily formed. Sulphydric acid water converts the oxyd into a black powder which remains long suspended and which does not resemble a mixture of copper with the protosulphid or subsulphid; the author regards it as Cu_4S. Cyanhydric acid also converts the oxyd into a black substance which probably consists of Cu_4Cy. The moist oxyd is not dissolved by ammonia, which distinguishes it remarkably from the suboxyd and protoxyd. Rose maintains that the suboxyd of silver usually written Ag_2O is really Ag_4O, and that ordinary protoxyd of silver is Ag_2O. This view, which he has for a long time defended, he extends to the alkaline metals, regarding soda and potash as Na_2O and K_2O. He recalls the formation by Bunsen of blue alkaline subchlorids by electrolysis, and states that these compounds can also be obtained by fusing potassium with chlorid of potassium, or sodium with chlorid of sodium, in a current of hydrogen gas. Rose considers these subchlorids as K_4Cl and Na_4Cl. He proposes to substitute for the received nomenclature of the basic oxyds, the terms quadrantoxyd, semioxyd, isoxyd, diploxyd and sesquioxyd, denoting respectively the oxyds whose formulas are written R_4O, R_2O, RO, RO_2, R_2O_3.—*Pogg. Ann.*, cxxx, 1. W. G.

[*Note.*—It appears at least, extremely probable, that the beautiful blue and violet colors produced by the action of metallic sodium or potassium upon certain organic bodies containing chlorine, may be explained by supposing that in these cases alkaline subchlorids are found like those mentioned by Bunsen and Rose. I recall, for example, the memoir of

Bouis on the Capryl series and the observations made by that chemist on the action of sodium upon the chlorid of Capryl.—W. G.]

8. *On compounds of silicium with oxygen and hydrogen.*—WÖHLER has obtained combinations of silicium with hydrogen and oxygen by the action of fuming chlorhydric acid upon an alloy of silicium and calcium, consisting essentially of $CaSi_2$. The siliciuret of calcium is gradually converted with evolution of hydrogen into a new substance which the author calls Silicon, not observing apparently that this name had already been frequently applied to silicium to indicate its analogy with carbon. The silicone—as we will write it to prevent confusion—is to be filtered off, thoroughly washed, pressed between folds of porous paper and dried over sulphuric acid, every precaution being taken to exclude light as much as possible. Silicone has a bright orange, yellow color; it is insoluble in water and alcohol and by heating becomes transiently of a deep orange yellow. More strongly heated it takes fire and burns, leaving silicic acid colored brown by amorphous silicium. Heated out of contact with the air it gives off hydrogen and leaves a mixture of silicic acid and silicium in brilliant blackish-brown leaves. When heated in a closed tube with water to a temperature of 190° C., silicone is rapidly and completely converted into white leaves of pure silicic acid while the tube contains compressed hydrogen. Light decomposes silicone with evolution of hydrogen gas, even beneath the surface of water, yielding a white substance which Wöhler terms *leucon* and which we will write *leucone*. Neither chlorine nor fuming nitric or concentrated sulphuric acid attack silicone. Fluohydric acid renders it at first white and then dissolves it. Alkaline solutions instantly convert silicone into silicic acid with strong evolution of hydrogen. In the presence of an alkali silicone reduces many metallic solutions, the evolved hydrogen being probably the reducing agent. The analyses of silicone lead to the formula $Si_8H_4O_6$ as most probable, though the formulas $Si_6H_3O_4$ or $Si_{12}H_6O_8$ express the results of two of the analyses better. Wöhler points out the analogy of these formulas to those of organic substances and suggests that there may hereafter be a special chemistry of the compounds of silicium as those of carbon. Leucone is a colorless body which appears to remain unchanged in the air. On heating in the air it behaves like silicone, which it also resembles in its behavior toward alkalies. Its formula appears to be $Si_8H_5O_{10}$ or possibly $Si_8H_6O_{10}$. Wöhler now considers it probable that the hydrated oxyd of silicium formerly described by Buff and himself, is really leucon and that the corresponding chlorid, bromid and iodid, have respectively the formulas $Si_6H_4Cl_{10}$, $Si_6H_4Br_{10}$, and $Si_6H_4I_{10}$, while if the former analyses were correct the formula of leucon would be $Si_6H_4O_{10}$. By the action of *dilute* chlorhydric acid upon $CaSi_2$ Wöhler obtained another compound of silicon, hydrogen and oxygen as a colorless body which ignited spontaneously in the air. Its formula is possibly $Si_8H_8O_{10}$. Compounds containing sulphur, selenium and tellurium were also obtained, but only imperfectly examined. The sulphur compound explodes violently when heated in a tube.—*Ann. der Chemie und Pharm.*, cxxvii, 257. W. G.

9. *The Characteristics of Thallium*[1]—*Derived from statements of Crookes, Lamy and Böttger, and from original observations.*—Thallium occurs in minute quantities in many native metallic sulphids, especially in iron and copper pyrites. Hence it is often found in commercial sulphur, in oil-of-vitriol and in the sediment of the sulphuric acid chambers in metallic copper, bismuth and cadmium, and in preparations derived from these substances. It likewise occurs in the flue-dust of furnaces and in certain mineral springs.

Thallium is a bluish-white, very soft and malleable, though not tenacious, metal. Its sp. gr. $=11\cdot8$. It is brilliant on a fresh-cut surface, but shortly tarnishes. It is easily fusible and volatilizes at a red heat. Before the blowpipe it emits copious fumes of oxyd which have a peculiar odor and exhibit a play of white, reddish and violet colors. In its chemical relations, thallium, in some respects, most resembles lead and silver; in others it is allied to the alkali-metals. It slowly dissolves in distilled water (far less readily in water containing earthy salts), especially when in a state of fine division. It dissolves readily in sulphuric and nitric acids and aqua-regia, slowly in chlorhydric and very slowly in acetic acid. Boiled with aqua-regia, terchlorid of thallium escapes in the vapors. Of the compounds of thallium with oxygen, there are known the protoxyd (TlO) and the teroxyd (TlO_3). The latter is violet-black or brown, insoluble in water, soluble in hot strong sulphuric acid. Its hydrate (TlO_3, HO) is brown and dissolves in chlorhydric, nitric and sulphuric acids. At high temperatures it loses its water but retains its brown color. On strong ignition the teroxyd loses oxygen and is converted into protoxyd. Protoxyd of thallium as hydrate is largely soluble in water and alcohol. Its solution reddens litmus, is caustic and alkaline; by evaporation in vacuo it is obtained crystallized in the form of yellow needles. It absorbs carbonic acid with avidity, unites with acids yielding crystallizable mostly soluble salts. *Sulphydric acid* does not affect acid solutions of thallium, but throws down from alkaline, as *sulphid of ammonium* does from neutral solutions, all the thallium they contain, as black sulphid of thallium. In very dilute solutions, a yellow, brownish-yellow or red-brown coloration is at first produced. On heating, the liquid may become purplish or blue by transmitted and yellow or brownish-red by reflected light from the suspended particles of sulphid, while the latter, when deposited, has a brownish tinge. Sulphid of thallium is characterized by its flocculent form and bulkiness: its separation is promoted by heating or agitation, and at the same time it becomes less voluminous. Sulphid of thallium is insoluble in sulphid of ammonium, in alkalies, alkaline carbonates and cyanids. It oxydizes to soluble sulphate on exposure in the moist state to the air, and must hence be washed with dilute sulphid of ammonium. It is slowly but perceptibly soluble in cold dilute acetic, chlorhydric and sulphuric acids, especially when exposed to the air, as happens when it is treated on a filter with these acids. It is readily soluble in nitric acid.—*Alkalies* and *alkaline carbonates* produce no precipitates in solutions of thallium.—*Chlorhydric acid* throws down from solutions that are not too dilute, protochlorid of thal-

[1] From the Editor's notes to a new edition of Fresenius' Qualitative Analysis in preparation, to be published by John Wiley, New York.

lium as a white curdy quickly-subsiding precipitate, which requires 50 parts of boiling water and 200 parts of cold water for its solution, and is less soluble in water containing chlorhydric acid.—*Iodid of potassium* (next to sulphid of ammonium the most sensitive reagent) gives a pale yellow precipitate of iodid of thallium, which appears to be slightly soluble either in water or excess of the reagent.—*Bichlorid of platinum* throws down a pale orange precipitate of platinchlorid of thallium which is slightly soluble in water and is decomposed on ignition, evolving chlorine with loss of thallium and leaves a crystalline alloy of platinum and thallium.—*Metallic zinc* separates all the thallium in the metallic state, from neutral solutions often in the form of brilliant radiated needle-shaped crystals, from acid solutions as a heavy black powder.

Thallium is in many cases most easily and certainly detected by spectral analysis. The spectrum is characterized by a single bright green line coincident with Baδ. This line is however usually perceptible for but a moment, owing to the volatility of the thallium compound, and hence its intensity and duration do not safely indicate the richness in thallium of pyrites, flue-dust, &c.

Of crude sulphur a piece as large as a pea is nearly burned away on a platinum loop and the residue is examined in the spectroscope; or better, the sulphur is mostly dissolved by means of sulphid of carbon, and what remains is tested spectrally. In pyrites, flue-dust, and lead-chamber sediment, it may be usually detected at once by the spectroscope. The sublimate procured by strongly heating finely pulverized native sulphids in a closed tube, often gives the reaction when none can be obtained directly from the sulphids themselves. S. W. J.

ANALYTICAL CHEMISTRY.—

10. *Estimation of Sulphuric Acid in salts of the alkalies.*—It is well known that precipitated sulphate of baryta may retain alkaline salts in quantities of 1·5 to 2 per cent, which cannot be removed by the most careful washing. STOLBA (*Dingler's Polyt. Jour.*, April, 1863) obtains the sulphate of baryta pure by digesting it (after washing until the wash-waters no longer react of baryta) with 40–50 c. c. of a cold saturated solution of neutral acetate of copper and some acetic acid, at nearly a boiling heat, for 10–15 minutes. (The commercial crystallized acetate of copper is purified from sulphuric acid and at the same time saturated with sulphate of baryta, by adding to its boiling solution a slight excess of chlorid of barium and acetic acid and filtering from the precipitate.) During the digestion, enough acetic acid must be present to prevent the formation of basic salt on boiling. Should basic salt form, which may be readily perceived at the bottom of the vessel, more acetic acid must be added, and the digestion must be renewed for 10–15 minutes. During the process, the vessel containing the precipitate should be constantly agitated. The alkaline salts retained by the sulphate of baryta undergo double decomposition with acetate of copper, and the resulting products all admit of entire separation from the precipitate by means of hot water. The precipitate is washed until no reaction for copper is manifest on mixing the washings with ferrocyanid of potassium. This method the author also found satisfactory for the estimation of sulphuric acid in presence of a large excess of nitrate of baryta and chlorid of barium.

S. W. J.

PHOTOGRAPHY.—

11. *Dry Process;* by MM. TEISSÈRE et JACQUEMET, of Marseilles.—Any collodion which gives good results by the wet process may be used in this, provided that it contains at least one per cent of iodids and ½ per cent of bromids. The following formula is recommended:

Ether,	60 cub. c. m.*
Alcohol,	40 "
Gun cotton,	1 gram.
Iodid of cadmium,	0·75 "
" " ammonium,	0·50 "
Bromid of ammonium,	0·40 "

The plate is covered as usual, and sensitized in a bath containing

Distilled water,	100 cub. c. m.
Nitrate of silver,	8 grams.
Glacial acetic acid,	2 cub. c. m.

The plate is then transferred to a bath of distilled and filtered water, where it should remain until the plate ceases to appear oily. It is then passed successively through three other baths of filtered water. In the first two, filtered spring water may be used, but the last should be filled with distilled water.

The plate is next washed in a solution of tannin, containing

Distilled water,	100 cub. c. m.
Tannin,	3 grams.
Alcohol of 40 pr. ct.	5 cub. c. m.

In preparing this solution the tannin should be first dissolved in the pure water, and filtered before the alcohol is added. Before applying the preservative, two portions of the solution should be measured out and placed in separate glasses. That from the first glass should be poured over the plate several times, until the coating has been thoroughly soaked. The excess is then drained off and the plate washed over with the solution in the second glass, which may be collected and used for the first treatment of a second plate. Lastly, the plate is washed under a tap supplied with pure water to remove the excess of tannin, and air dried.

The time of exposure for views is stated as from 1 to 1¼ minutes with a quarter plate Jamin view-lens of 10 c. m. focus, under best conditions.

Before developing, the edges of the plate should be varnished with a fine camel's hair brush. Having soaked the plate for a few minutes in pure water, it is next dipped in the silver bath used for sensitizing and drained. It is then dipped into a shallow flat glass dish containing a sufficient quantity of the following developer:

Distilled water,	200 cub. c. m.
Pyrogallic acid,	1 gram.
Glacial acetic acid,	10 cub. c. m.

By rocking the dish the liquid is kept continually rolling over the surface, and the development is carefully watched by the light transmitted through the glass.

If the exposure has been well timed the image will appear slowly, but with all the details sharply defined and the lights wholly unstained. It is then only necessary to add to the developer, a few drops at a time, of a weak solution of nitrate silver until the blacks are sufficiently intense

* 28·34 cubic centimeters = 1 liquid ounce. 1 gram = 15·4 grains.

for a good negative. If the exposure has been too much prolonged the image will appear rapidly and will have a tendency to fog. A good result can nevertheless be frequently obtained even then by adding pure acetic acid to the developer and thus retarding the process. Towards the end, if necessary, a little of the silver solution may be added to give the required intensity. If the exposure has been too short the image will be proportionally slow in coming out, and the details will not readily appear. The development can then be hastened, and a satisfactory negative generally obtained, by adding to the developer a few drops of a saturated solution of pyrogallic acid, followed by one or two drops of a weak solution of silver. If this is not sufficient, increase the amount of both until the details appear, and then intensify by adding acetic acid and solution of silver if necessary. If during the process the developer becomes clouded it should be at once poured off and replaced by a fresh quantity of the original developer. When the image is sufficiently intense, the plate is carefully washed and fixed in a solution of hyposulphite of soda, in the ordinary way. After again washing, a weak solution of gum arabic, is spread over the plate which is then dried and varnished.

It will be seen that the above process is essentially the same as that of Maj. C. Russell, described by Prof. Emerson in this Journal, vol. xxxiv, p. 134. It contains, however, some details as to formulas and manipulation which are new and of practical value. Our experience has been that although the washing of the sensitized plate should be begun in a bath of distilled water, it may be finished under a tap as well as by the more complex process here recommended. Moreover, we find an advantage in soaking the plate in a bath of hot water before developing, as recommended by Dr. Draper, and we employ by preference the developer of Major Russell to any we have yet seen. Our formula for the developer is: For solution No. 1, pyrogallic acid 4 grams, alcohol of 90 pr. ct. 25 cub. c. m. For solution No. 2, nitrate of silver 1·2 grams, citric acid 3 to 4 grams, according to circumstances, distilled water 25 cub. c. m. We begin by adding to 25 cub. c. m. of pure water 16 drops of No. 1 and 8 drops of No. 2. With this we flow the plate and keep the developer rolling over the surface until the details appear, and then add to the developer a few drops at a time of No. 2, until the required intensity is obtained, returning the developer to the measuring-glass before each addition. If the plate has been over exposed we retard the process by adding acetic acid. If under exposed, we hasten the development by increasing the amount of pyrogallic acid and subsequently of nitrate of silver, when the details are well out. A few experiments gives the operator perfect control over the process. If the developer becomes turbid during the process, it should be at once poured off the plate, washed, and the process renewed with a fresh portion of the developer, increasing the amount of citric acid, which tends to prevent this change. To persons who have not steady hands, the use of a shallow glass dish in developing as recommended above will be found of great advantage, especially when the process is prolonged.

Another modification of the dry process proposed by Mr. Fassitt, one of our own photographers, is worthy of attention. It is based upon the use of an infusion of malt instead of tannin as the preserving agent. The infusion is prepared in the following way:

Seven parts of crushed or ground malt are digested with 24 parts of warm water, the mixtures being well stirred for 10 or 15 minutes at a temperature of 70° C. It is then slowly cooled and, having been strained through a cloth, is carefully filtered.

The same collodion and silver bath are used as in the wet process. When the plate is sensitized it is placed in a flat dish of distilled water, which is waved over the surface until the plate ceases to appear oily. It is then drained for a moment and the malt solution turned on and off, as directed above for the tannin, when the plate is again drained and dried. The exposure is about the same as with the tannin process. Before developing, the plate is soaked in water and well washed under a tap. It is then dipped for a minute in the silver bath, drained, and developed with the usual iron developer. The formula recommended is as follows:

Crystallized green vitriol,	120 to 170 grains.
Glacial acetic acid,	5 drachms (liquid).
Water,	10 ounces.

If sufficient intensity is not obtained at first, to a fresh portion of the same developer may be added a few drops of the following solution, and the process repeated:

Nitrate of silver,	15 grains.
Citric acid,	15 "
Water,	1 ounce.

The results are said to be superior to those of the tannin process, especially for transparencies on glass.

M. Julhiet, a French photographer of Mons, gives the following receipts for the dry collodion process, which are said to give remarkably fine negatives, excellently well adapted for enlarging by the solar camera, and the beauty of the enlarged prints made by him he attributes entirely to the delicacy of the negative:

Collodion.

Alcohol,	400	grams.
Ether,	600	"
Gun-cotton,	8	"
Iodid of ammonium,	5	"
Iodid of cadmium,	3	"
Bromid of ammonium,	0·5	"
Bromid of cadmium,	0·5	"
Pure iodine,	0·2	"

Should be kept for a month to a month and a half, until the color, at first red, becomes orange.

Silver Bath.

Nitrate of silver,	5	grams.
Glacial acetic acid,	5	"
Water,	100	"

Solution of Tannin.

Tannin,	5	grams.
Water,	100	"
Alcohol,	2	"

Before developing, the plate is moistened with a small amount of distilled water without washing and then flooded with a solution containing

Nitrate of silver,	3	grams.
Water,	100	"
Alcohol,	5	"

which is allowed to rest on the plate for a minute and then drained off, when the developer is applied. Two solutions are prepared.

No. 1.	Pyrogallic acid,	1	gram.
	Water,	200	"
	Glacial acetic acid,	25	"
	Alcohol,	10	"
No. 2.	Saturated solution of gallic acid in pure water.		

The developer consists of 5 grams of No. 1, mixed with 15 grams of No. 2, and is rolled on the plate in the usual way until it becomes turbid. It should then be poured off, and the plate washed and fixed in the usual way. If, however, the details are not all brought out by the first developing, the process should be repeated with a fresh portion of the same solution.

We hope that the details here given may serve to make the dry process more popular with our amateur photographers. For out-of-door work, when the time of exposure is not an important point, it is so much more convenient than the wet process that it will be greatly preferred if once fairly tried. Care in regard to the purity of the materials and the condition of the baths will ensure success by the one process as certainly as by the other. J. P. C., JR.

III. METALLURGY.

1. *On the Occurrence of Titanium in Pig Iron, and some Remarks on the Use of Titaniferous Minerals in the Manufacture of Iron and Steel;* by EDWARD RILEY, F.C.S.[1]—The presence of small cubical red crystals, with a metallic lustre, has long been observed in the hearths of old blast furnaces—they may be said, in fact, to be universally present to a greater or less extent—occurring most largely in the hearths of furnaces where clay iron-stone, or siliceous iron ores (such as the red hematite and Forest of Dean ores) are used. The crystals are always more abundant when the furnaces are used for making the best grey iron, the most perfect crystals that have come under the author's observation being some from the Low Moor ironworks; while the largest quantity were from the iron works in the Forest of Dean, and the Pontypool iron works, some of which crystals were massed together, and had the appearance of copper. The iron from the above works has a great commercial reputation for its quality, and, as a rule, the better the quality of iron made in a blast-furnace the more titanium is found in the hearths.

In the examination of a large number of the hearths of the Welsh blast-furnaces, where common iron for rails and bars is chiefly made—in one works eighteen were inspected during their removal—the crystals were observed disseminated through the mass, but were only very small in size and minute in quantity.

The red crystals were first supposed by Wollaston to be titanium; but Wöhler has subsequently shown them to be a mixture of a nitrid and cyanid of titanium, containing 18 per cent of nitrogen and 4 per cent of carbon. The composition of the crystals, however, varies—as some will be found to be readily converted into titanic acid on boiling with strong nitric acid, while others are quite unattacked by this reagent.

[1] *Read before* the British Association at Newcastle, and extracted from the *London Chemical* News, Nos. 206 and 207, Nov. 7 and 14, 1863.

Jntil recently the source of these crystals has not been very clearly ounted for, as in all analyses of materials used in the blast-furnace, nic acid or the oxyd of titanium was very rarely if ever mentioned. anic acid has hitherto been considered an oxyd occurring only in iute quantity, or found in minerals that are not largely disseminated uch as in rutile and anatase, in the pure or nearly pure state, in iser- , ilmenite, and numerous other minerals, mostly mixed with a large centage of iron. The following are two analyses of some Norwegian that has been used in the blast-furnace, and will be subsequently re- 'ed to:—

	1.	2.
Magnetic oxyd of iron,	46·15*	54.72
Titanic acid,	36·88	40·80
Silica,	13·32	1.58
Magnesia,	2·07	2·13
Lime,	·78	·66
Bisulphid of iron (iron pyrites),	1·05	....
	100·24	99·89
[etallic iron,	33·39	39·62

No phosphoric acid was detected.

In experience of eleven years, in the almost exclusive examination of s and products from iron works, has proved to me that titanium ought longer to be considered one of the rarer elements, as it occurs very erally disseminated, and is a universal constituent of all clays, as was nted out by me in a paper read before the Chemical Society last year, l recently published, from which the following table is extracted—giv- the percentage of titanium in the principal fire bricks used in London. e methods adopted to determine titanium are not at all satisfactory; following results would certainly be too low rather than too high, as all probability the whole of the titanic acid was not obtained:—

le showing the amount of Titanic Acid in Fire Bricks and Clay. A complete nalysis of these Bricks was not made, except those of Dowlais, and the Titanic Acid is too low and only represents in part the amount present.

Description of Brick.	Silica. Per cent.	Titanic Acid. Per cent.
Stourbridge (Slickman),	65·11	1·05
" (Rufford),	63·42	1·05
Newcastle (Lucas),	60·49	·60
" (Stephenson,)	60·60	·42
" (Ramsey),	55·86	·67
Wortley Leeds (Ingham),	62·96	·96
Harwarden, North Wales,	62·39	·69
Dowlais, South Wales,	63·02	1·04
Yellow London clay, (dry),	64·52	·50
Ewell brick, Surrey,	91.84	trace
Dinas brick, South Wales,	94·33	"
Black alder, Devonshire,	75·16	"

From the above results it is apparent that in furnaces where clay iron- ne is used, the source of the titanium is the clay in the ore and the ile attached to it. In siliceous ores, such as the hematites, the titanium st probably is obtained from the rutile, which is frequently found in artz, and perhaps partly from the fire bricks and shale, which is fre- ently used.

* These analyses were made in my laboratory by my late pupil, Mr. Betley.

The minerals of titanium, viz., rutile and titanic acid mixed with iron, are largely found in Norway, and can be brought over to this country at a very cheap rate. Rutile, which, commercially speaking, is pure titanic acid, can be purchased here for 10*l.* per ton, or even less if it were taken in large quantity; and iron ores, such as shown in the analyses given, can be bought at from 20s. to 40s. per ton.

Recently a series of patents have been secured by Mr. R. Mushet, for the use and application of titanium in the manufacture of iron and steel, and for alloying titanium with iron and steel, in which very beneficial results are claimed for the action of the titanium.

Before entering upon the question as to the effects of titanium, it will be well to consider if titanium alloys with iron, and if so, to what extent. Up to the end of 1862 the author examined samples of pig iron, and Mr. Mushet's steel itself specially, with the view of detecting titanium; but in no case could any distinct evidence of its presence be proved, except occasionally as a minute trace. My conclusion at that time was that titanium did not alloy with iron, and my opinion on this point was strengthened by the results of M. St. Claire Deville, of Paris, who has paid especial attention to the subject; and Dr. Percy observed also that he could never find it. M. St. Claire Deville mentioned to me, in the course of some conversation on the subject, that he had occasionally seen red crystals of titanium in the pig itself, and it was only then that he could detect the presence of the metal. The general opinion of English chemists, who had paid attention to the subject, was that titanium did not practically alloy with iron.

At the end of last year some samples of pig iron were submitted to me, one of which was made from red hematite mixed with 7½ per cent of Norwegian ore, similar to the analyses previously given. The analysis of this sample of pig gave distinct evidence of the presence of an appreciable amount of titanium; and in other samples sent at the same time, reported to be made from red hematite alone, to my surprise titanium was also found, but to not quite such a large amount. This could not be satisfactorily accounted for until the persons sending me the pig informed me that 10 per cent of Irish (Belfast) ore had been mixed with the hematite; and on examining this ore it was found to contain some amount of titanium, as seen by the following analysis:

Belfast Iron Ore, dried to 280° Fahrenheit.

Silica,	9·87
Peroxyd of iron,	27·93
Protoxyd of iron,	5·08
Alumina,	34·57
Titanic acid,	3·51
Manganese,	traces
Lime,	·91
Magnesia,	·62
Combined water,	19·36
Phosphoric acid and copper,	traces
	101·85
Metallic iron, per cent,	23·5

The use of this ore in the furnace was attended with considerable advantage on account of the high percentage of alumina it contains, thus

orming a more readily fusible double silicate with the silica contained n the hematite.

The method pursued to detect titanium was the same as that adopted nd given in my paper in the *Journal of the Chemical Society* for 1862, age 311. It, however, required no very special method to point out ts presence, and it was readily found in the silica obtained in the portion f pig used for the determination of phosphoric acid, by simply treating he silica with fluohydric and sulphuric acids, evaporating to dryness, nd igniting. Thus, 120·845 grains of pig gave silica 4·29, which left residue, when treated as above, of ·31. This was slightly tinged in olor by iron, and on fusing it with bisulphate of potash, dissolving the used mass in cold water, and boiling, the characteristic precipitate of itanic acid was obtained, which gave the reactions peculiar to titanic cid in the blowpipe flame with microcosmic salt. The whole of the itanic acid cannot be separated with the silica, and a considerable mount is in solution with the iron.[3] However, to determine accurately

[3] The following are methods that have been adopted to separate the titanic acid: —A weighed portion of the borings of the pig are treated with fuming nitric acid n a flask, a few drops of chlorhydric acid added from time to time, the whole eing well boiled. The contents of the flask are then transferred into a porcelain ish, evaporated to dryness, and heated strongly. On cooling, it will be found that xyd of iron readily detaches itself from the dish, and can be easily transferred nto a beaker, the portions left on the dish being dissolved in chlorhydric acid, and poured on the contents of the beaker; the dish may be washed, or nearly so, with strong chlorhydric acid. The contents of the beaker are boiled for from two to three hours until complete solution of the iron is effected; and as some quantity of chlorhydric acid is required for this, my usual plan is to allow a large portion of the excess of acid to evaporate in the beaker, retaining only as much as is requisite to keep up in solution the iron. The silica is filtered off in the usual way, after diluting with water and adding a few drops of chlorhydric acid on the filter to dissolve the basic salt formed by the water. By this means the silica can be obtained very nearly white after burning off the graphite, and very little iron will be found with it except the pig contain much phosphorus, as the silica invariably contains more or less phosphate of iron from insoluble phosphid of iron, which cannot be completely dissolved out by chlorhydric acid. In the filtrate from the silica the sulphur in the pig may be determined, and subsequently the phosphoric acid, by removing first the excess of chlorid of barium used to precipitate the sulphuric acid. Before determining the titanium and phosphoric acid, the residue from the silica should be fused with bisulphate of potash, dissolved in water, and added to the solution of iron in which the phosphorus and titanium are to be determined. The solution is reduced with sulphite of soda, and excess of sulphurous acid is driven off by boiling. The solution is then nearly neutralized with ammonia, and acetate of ammonia or soda added; and if there is only a small quantity of phosphoric acid, there will always be sufficient peroxyd of iron to precipitate it, but if not, a few drops of nitric acid must be added, so that the precipitate produced is distinctly red, and the solution is boiled and filtered as quickly as possible. This precipitate may be at once treated, or if it contains much peroxyd of iron in excess of that sufficient to form phosphate of iron, it is better to redissolve it in HCl, re-reduce it with sulphite of soda, and repeat the operation above described. The precipitate is then dissolved in chlorhydric acid, and chlorid of magnesium, ammonia, chlorid of ammonium, and tartaric acid added, the precipitate produced being allowed to stand two nights; then the ammonia-phosphate of magnesia filtered off, dried, ignited, and weighed, and the phosphoric acid calculated from the pyrophosphate of magnesia. The filtrate from the phosphoric acid is treated with sulphid of ammonium, and the sulphid of iron separated, the filtrate evaporated o dryness, ignited, and burnt in a muffle; or evaporated nearly to dryness, transerred into a Florence oil flask, and treated with fuming nitric acid until all the tar-

titanic acid, oxyd of iron ought to be entirely absent, as it either prevents its precipitation altogether, or materially retards it. This is, in fact, the great reason why titanic acid has been so frequently overlooked, and so many errors made. Some special experiments on this point will be found in my paper previously alluded to.

Titanium may, however, be found more satisfactorily and more readily, during the process usually adopted to determine the amount of graphite in pig iron, provided a large quantity of the pig be operated on. In the analysis of the pigs alluded to, about 200 grains of the pig were dissolved in dilute chlorhydric acid; when the pig was nearly all dissolved and the action of the acid had ceased, more chlorhydric acid was added, and the solution well boiled, so as thoroughly to extract all the iron. The solution was then thrown on dried counterpoised filters encircling each other, and the filter well washed to remove all the iron. It was then treated with dilute potash, and washed once; then re-treated with it, so as to remove entirely the silica. The potash was thoroughly washed out, and the filter treated with chlorhydric acid, thoroughly washed and dried at 250° F., until the weight was constant. This gave the graphite, on burning which a residue of a dirty light brown color was left, which, on being fused with bisulphate of potash and treated as before, proved that the residue was nearly pure titanic acid, as will be seen from the results below:—

	Grains of pig taken.	Graphite and Titanic acid.	Residue after burning.	Titanic acid obtained.
No. 1 Pig	205·68	7·82	1·23	1·085
" 2 "	207·05	7·85	·835	·745
" 3 "	216·86	7·04	·33	·28

The amount of titanic acid, or rather residue, obtained from the silica after it had been volatilized with fluohydric and sulphuric acids, when the pig was dissolved in nitro-chlorhydric acid, evaporated to dryness, and redissolved in chlorhydric acid—is given below:—

	Grains of pig taken.	Silica obtained.	Residue by fluohydric and sulphuric acids.
No. 1	120·845	4·29	·31
" 2	127·93	8·659	·20
" 3	122·55	9·22	·265

taric acid is destroyed; in either case the residue is fused with bisulphate of potash, or where nitric acid is used, this is driven off with sulphuric acid. The fusion with bisulphate of potash is dissolved in cold water, boiled for some hours, and allowed to stand a night in a warm place, when the titanic acid is filtered off and washed with dilute sulphuric acid—dried, ignited, and weighed. If the determination of phosphoric acid is not required, then the precipitate produced (either by one treatment or two) by the alkaline acetate, may be dried (without washing), burnt, and fused with bisulphate of potash, dissolved in cold water, when a little phosphate of iron, which remains insoluble, is separated; and the solution being boiled, the titanic acid is precipitated, and may be separated as before.

Neither of the above two processes are very satisfactory for the quantitative determination of titanic acid. The first is very tedious, and destroying the tartaric acid very troublesome; while in the second method, the phosphate of iron (insoluble in the bisulphate of potash) cannot be washed without its passing through the filter, and very frequently also the small amount of iron keeps up the titanic acid, as iron even in small quantities has a very great effect in preventing the precipitation of titanic acid, so that it is always advisable to add a little sulphite of soda, *which reduces* the oxyd of iron and facilitates the precipitation of the titanic acid.

This residue, chiefly titanic acid, contained, however, some iron, and was not so pure as that obtained by burning the graphite, given in the above table. The following are the tabulated results of the analyses of the three samples of pig:

	I.	II.	III.
Carbon,	3·31	3·18	3·11
Silicium,	1·86	3·28	3·55
Iron,	93·47	92·79	92·04
Manganese,	·50	·48	1·09
Sulphur,	·071	·058	·112
Phosphorus,	·076	·062	·093
Titanium,	1·150	·71	·470
	100·437	100·560	100·465

In all these the carbon was combined; and traces of antimony, nickel, copper, and cobalt were found in all three samples. Samples I. and II. were No. 3 grey iron; and sample III. was bright iron.

The percentage of titanium given in the above analyses differs from that in the preceding table, due probably to the chlorhydric acid dissolving some of the titanium. From 15 to 16 grains of the pig are dissolved in nitro-chlorhydric acid, and the solution evaporated to dryness, the silica separated in the usual way, and volatilized with fluohydric and sulphuric acids, the residue fused with a little bisulphate of potash, dissolved in cold water, and added to the filtrate from the silica. The solution is precipitated with acetate of soda or ammonia, first nearly neutralizing it with ammonia; after boiling well, the basic peracetate of iron is filtered off, and well washed, adding occasionally a drop or two of the alkaline acetate. The filter is then dissolved in chlorhydric acid, and peroxyd of iron precipitated by ammonia, filtered, dried and ignited in the usual way. The peroxyd of iron is then dissolved in chlorhydric acid, and the small amount of silica present separated, the solution is reduced with sulphite of soda, and the iron determined with a standard solution of bichromate of potash. This gives the percentage of iron, or of pure peroxyd of iron; and the difference between the peroxyd of iron weighed and that determined by standard solution is considered to be titanic acid and phosphoric acid. The phosphoric acid having been determined by another distinct operation, the amount present in the peroxyd of iron is calculated and deducted from the above difference—the remainder being considered to be titanic acid, from which the percentage of titanium in the pig is calculated. This determination by loss is not so satisfactory as a direct determination, and is probably a little high; and the true percentage of titanium will probably lie between that given in the table and that in the analyses. Subsequently to the analyses of the above three samples of pig, a sample of iron made wholly with hematite was tested for titanium, but none was detected. Recently I have examined some samples of pig iron made from a mixture of Cornish ores, Irish bog-ore and hematite ore; the result shows that the pig contains some amount of titanium; the following is a partial analysis[4] of the Cornish ores used:

[4] Analysis made in my laboratory by Mr. Betley.

Siliceous matter, - - - -	23·38	21·70	27·18	21·03
Peroxyd of iron, - - - -	41·96	56·32	47·32	70·20
Peroxyd of manganese, - -	25·77	16·11	16·25	2·45
Percentage of metallic iron, -	29·38	39·43	33·14	49·14
" " manganese,	16·08	10·25	10·34	1·55

These ores contained a little phosphoric acid.

The following are the results of the analyses of three samples of this pig; the titanium being determined as in the other analysis of pig given:—

	I.	II.	III.
Graphite, - - - - - -	3·12	3·010	2·615
Combined carbon, - - - -	·310	1·020	·074
Silicium, - - - - - -	2·590	2·550	3·325
Iron, - - - - - - -	87·900	86·880	84·256
Manganese, - - - - -	5·850	6·370	8·087
Nickel and Cobalt, - - -	·060	·110	....
Copper with a little antimony, -	·060	·045	·064
Phosphorus, - - - - - -	·147	·154	·201
Sulphur, - - - - - -	·026	·026	·017
Titanium, - - - - - -	·790	1·150	1·629
	100·853	101·315	100·268

Samples I. and II. were made with a mixture of ⅓ Cornish, ⅓ Irish bog-ore, ⅓ hematite; and sample III, ⅓ Irish bog-ore, ⅔ Cornish ore. The Irish bog-ore contained 7 to 9 per cent of manganese.

These samples of pig were numbers 1 and 2, with here and there patches of bright iron. Nos. 1 and 2 were drilled, but were rather hard; No. 3 was too hard to drill, or could only be drilled with great difficulty. They were made specially to see to what extent, on a large scale, manganese could be made to alloy with iron; and also if a pig could not be made in this country similar to "Spiegeleisen," and adapted for the purpose of carbonizing the iron after blowing by the Bessemer process. The percentage of manganese in the analysis of sample III. is the highest that has ever come under my notice in grey pig-iron.

The question now becomes—In what state does the titanium exist in the pig—is it, or is it not, alloyed with it? The pig itself has been carefully examined with the microscope to see if any red nitrid crystals could be discovered, but no indications of them have been seen. The residue, after dissolving the pig in chlorhydric acid, washing out all soluble matter, and drying, has also been examined, but only distinct graphite plates could be seen, with transparent gelatinous silica, having the appearance of chalcedony; and also some of this residue, after the silica had been separated, was examined, but no indication of any other substance besides the graphite could be seen. From the above it is evident that the titanium must be either disseminated through the pig in a finely divided amorphous condition, or it must be alloyed with it.

Samples of Mr. Mushet's steel, in the manufacture of which titaniferous ores had been used, were also examined, but in no case has any evidence of the presence of titanium been detected. Several experiments conducted on a small scale with titaniferous iron ores show that no increase in the yield of iron is obtained by the presence of titanic acid, *and that* when this substance is present in any quantity it is very diffi-

cult to flux or to get a good cinder; so that it is always necessary to have a large amount of an easily fusible silicate before satisfactory results can be obtained in the reduction of ores containing titanic acid. The following are the results of the dry assays of some titaniferous iron ore, containing by wet assay 39·08 per cent of iron:

	1.		2.	
Iron ore,	500	500	500	500
Clay,	100	100	50	100
Lime,	250	230	150	180
Anthracite,	80	75	75	70
	930	905	775	850

The two assays marked 1 were perfect, and a good button of iron obtained, yielding 37·76 per cent of iron in the ore, the cinder being of a dark blue color; but in the assays marked 2, the cinder was almost black, semi-fused, and contained cavities with acicular crystals.

It must, however, be admitted that when titanic acid is present in iron ores, it appears to impart a steely nature to the iron reduced from them, somewhat similar to that obtained by the use of manganese; and fluxes that have been used with advantage at Sheffield have, on analysis, been proved to contain a high percentage of titanic acid. The pig iron made with 7½ per cent of titaniferous iron ore, of which the analysis is given, proved also to be an iron of very great strength, and excellent quality both for castings and for the Bessemer process.

In conclusion, my opinion as to the use of titanium is, that it appears to have some beneficial effect in the manufacture of iron and steel, and to act somewhat similarly to manganese. The *rationale* of its action possibly is that the titanium acts as a carrier of cyanogen to the steel, from its known affinity for carbon and nitrogen. The action, however, of manganese is by no means well understood; the same may be said of the cyanids; and to determine it requires the experiments to be more carefully conducted than has been hitherto done, before we can solve the question as to the part (if any) that nitrogen plays in the manufacture of steel. The above points are at the present time engaging my attention; but my object in this paper is to prove that under certain conditions titanium is a constituent part of pig-iron, and not to enter into theoretical considerations on the composition of iron and steel.

2. *On Aluminum and Aluminum-bronze;* by I. L. Bell, the Mayor of Newcastle.—The progress of the manufacture of this, so far as the arts are concerned, new metal has scarcely been such as to require much to be added to those admirable researches bestowed upon the process by the distinguished chemist, M. St. Clair Deville, of Paris. Upon the introduction of its manufacture at Washington, (Eng.), three and a half years ago, the source of the alumina was the ordinary ammonia alum of commerce—a nearly pure sulphate of alumina and ammonia. Exposure to heat drove off the water, sulphuric acid and ammonia, leaving the alumina. This was converted into the double chlorid of aluminum and sodium by the process described by the French chemist and practised in France, and the double chlorid subsequently decomposed by fusion with sodium. Faint, however, as the traces might be of impurity in the alum itself,

they to a great extent, if not entirely, being of a fixed character when exposed to heat, were to be found in the alumina, from which, by the action of the chlorine on the heated mass, a large proportion, if not all, found their way into the sublimed double chlorid, and once there, it is unnecessary to say that under the influence of the sodium any silica, iron, or phosphorus found their way into the aluminum sought to be obtained. Now, it happens that the presence of these impurities in a degree so small as almost to be infinitesimal, interferes so largely with the color as well as with the malleability of the aluminium, that the use of any substance containing them is of a fatal character. Nor is this all, for the nature of that compound which hitherto has constituted the most important application to this metal—I mean aluminium-bronze—is so completely changed by using aluminium containing the impurities referred to, that it ceases to possess any of those properties which render it valuable. As an example of the amount of interference exercised by very minute quantities of foreign matters, it is perhaps worthy of notice that very few varieties of copper have been found susceptible of being employed for the manufacture of aluminium; and hitherto we have not at Washington, nor have they in France, been able to establish in what the difference consists between copper fit for the production of aluminium-bronze and that which is utterly unsuitable for the purpose. These considerations have led us both here and in France to adopt the use of another raw material for the production of aluminium, which either does not contain the impurities referred to as so prejudicial, or contains them in such a form as to admit of their easy separation. This material is *Bauxite*, so called from the name of the locality where it is found in France. It contains—

Silica,	2·8
Titanium,	3·1
Sesquioxyd of iron,	25·3
Alumina,	57·4
Carbonate of lime,	0·4
Water,	10·8
	99·8

The bauxite is ground and mixed with the ordinary alkali of commerce, heated in a furnace. The metal is so extensively used in the arts as to keep the only work in England, namely, that at Washington, pretty actively employed. As a substance for works of art, when whitened by means of fluohydric and phosphoric acid it appears well adapted, as it runs into the most complicated patterns, and has the advantage of preserving its color from the absence of all tendency to unite with sulphur or become affected by sulphuretted hydrogen. A large amount of the increased activity in the manufacture referred to is due to the exceeding beauty of its compound with copper, which is so like gold as scarcely to be distinguishable from that metal, with the additional valuable property of being nearly as hard as iron.—*Chemical News*, No. 202, Oct. 17th, 1863.

3. *Processes of Silver and Gold Extraction;* by GUIDO KUESTEL. 8vo. 327, with 7 lithographic plates. (Carlton) San Francisco, 1863.—*From the title* page we learn that this work treats of the processes in use

in Nevada and California for the extraction of gold and silver, and is intended especially for the mining public of California and Nevada. The first part contains a chapter on the blowpipe, a description of gold and silver ores and the methods of assaying them, besides the extraction processes above alluded to. Part second, is a treatise on the general metallurgy of silver ores and is translated from Kerl's "Hüttenkunde." It contains further, a valuable series of tables showing the amount of fine silver per ton of ore and the values of silver and gold per ounce in the bar. The book seems to have been written and arranged with considerable care by one who evidently understands his subject, and from our examination of it we should think it to be well adapted for the purpose for which it was prepared.

IV. AGRICULTURAL CHEMISTRY.

1. *Die Chemie in ihrer Anwendung auf Agricultur und Physiologie, von* JUSTUS *von* LIEBIG. *In zwei Theilen. Siebente Auflage. Erster Theil: —Der Chemische Process der Ernährung der Vegetabilien. Zweiter Theil: —Die Naturgesetze des Feldbaues. Braunschweig,* 1862. Also *The Natural Laws of Husbandry,* by JUSTUS von LIEBIG. Edited by JOHN BLYTH, M.D. New York: D. Appleton & Co., 1863.—The seventh edition of Liebig's great work on Agricultural and Physiological Chemistry appeared in 1862, in two volumes of nearly 1100 pages 12mo. The first of these is essentially a revision of the 6th edition, save that the chapter on Eremacausis is omitted, and a voluminous table of ash-analyses is appended. The whole is prefaced by a long introduction (156 pp.), which is occupied with some historical matters and the author's justification of his own course in reference to agricultural science.

The second volume, of which the English edition by Dr. Blyth is a faithful and spirited translation, is a new book whose scope may be imperfectly gathered from the following titles of its chapters:

Chap. I. The Plant; Chap. II. The Soil; Chap. III. Action of Soil on Food of Plants in Manure; Chap. IV. Farm-yard Manure; Chap. V. The System of Farm-yard Manuring; Chap. VI. Guano; Chap. VII. Poudrette—Human Excrements; Chap. VIII. Earthy Phosphates; Chap. IX. Ground Rape-Cake; Chap. X. Wood-Ash; Chap. XI. Ammonia and Nitric Acid; Chap. XII. Common Salt, Nitrate of Soda, Salts of Ammonia, Gypsum, Lime.

This work is written in the earnest captivating style which characterizes the productions of Liebig; it displays vast knowledge and will be of great service to the science of agriculture by exciting discussion and research.

The work is largely devoted to the advocacy of certain doctrines which are peculiar to the author, or which, at least, have been so developed and defended by him as to bear his stamp henceforth: doctrines which are fundamentally opposed to older views, and which, we may add, are every one of them capable of utter refutation. The chief heresies which are promulgated in the Natural Laws of Husbandry are—1. that the radication of plants is proved to account for their different adaptedness to different soils and fertilizers. 2. That the universally active process of gaseous and liquid diffusion (*osmose*) does not apply in full force to the

feeding of plants, whether land or aquatic. 3. That the soil has no *solution* of matters, nutritive to vegetation, circulating in it. 4. That plants acquire their food, as good as wholly, from the insoluble matters of the soil by the direct action of their rootlets. 5. That manures must be absorbed by the soil before they can be of use to plants. 6. That nitrogenous manures, especially salts of ammonia, act chiefly by solving the phosphates of the soil. 7. That artificial supplies of nitrogenous nutriment to agricultural plants are unnecessary and in the end hurtful. 8. That the so-called improved agriculture—the high farming—of the present day, is a system of robbery and spoliation. 9. That the common practice of agriculture in Europe and America is inevitably leading to the exhaustion of the soil, the poverty, starvation and final downfall of the nations. 10. That agriculture as practiced in China and Japan is, in the long run, superior to that of so called enlightened countries.

These doctrines, which represent the salient points of the work, are urged with wonderful vigor and apparently with great conclusiveness. The work however is not free from fallacious and sophistical reasoning, nor indeed from contradictions which destroy confidence in the author's conclusions. While no little display is made of the results of late researches, many statements are advanced and many facts are assumed, which late researches have made wholly untenable. The "Natural Laws of Husbandry" is an ingenious and learned effort, but not one, we are bound to say, which faithfully reflects the present state of agricultural science. S. W. J.

2. *On a function of Roots.*—HENRICI (*Henneberg's Journal für Landwirthschaft*, 1863, p. 280 et. seq.) has made some ingenious and interesting observations on the function of roots in supplying water to the plant, and on the development, under certain conditions, of special roots destined for this purpose. It is a matter of not infrequent occurrence that plants send roots into wells, cisterns, drain-pipes, &c. where they exist in continual contact with a body of water. In drain-pipes the roots of plants usually considered to be free from aquatic tendencies, such as rape (*Brassica*), sometimes accumulate to a surprising extent. Henrici surmised that the roots which most cultivated plants send down deep into the soil, even when the latter is by no means porous or inviting, are designed especially to bring up water from the subsoil for the use of the plant. The following experiment was devised for the purpose of establishing the truth of this view. On the 13th of May, 1862, a young raspberry plant, having but two leaves, was transplanted into a large glass funnel filled with garden-soil, the throat of the funnel being closed with a paper filter. The funnel was supported in the mouth of a large glass jar, and its neck reached nearly to the bottom of the latter, where it just dipped into a quantity of water. The soil in the funnel was at first kept moderately moist by occasional waterings. The plant remained fresh and slowly grew, putting forth new leaves. After the lapse of several weeks, four strong roots penetrated the filter and extended down the empty funnel-neck through which they emerged, on the 21st of June, and thenceforward spread rapidly in the water of the jar. From this time on, the soil was not watered any more, but care was taken to maintain the supply in the jar. The plant continued to develope slowly, its leaves however did

ire a vivid green color, but remained pale and yellowish; they wither until the usual time late in autumn. The roots continued and filled the water more and more. Near the end of December t had 7–8 leaves, and a height of 8 inches. The water-roots ;orous, very long and beset with numerous fibrils and buds. In el tube the roots made a perfect tissue of fibers. In the dry the funnel the roots were less extensively developed, yet exhibited cy buds. The stem and the young axillary leaf-buds were also ıp. The water-roots being cut away, the plant was put into garand placed in a conservatory where it grew vigorously, and in 'e two offshoots.

xperiment makes it quite certain that plants extend a portion of)ts into the subsoil chiefly for the purpose of gathering supplies r. S. W. J.

V. GEOLOGY.

ntributions to Paleontology; by Prof. JAMES HALL. (Appendix e Sixteenth Report of the Regents of the University of the State York on the condition of the State Cabinet of Natural History, ?rofessor Hall has issued, in advance of publication, his Contribu-Paleontology in the *Sixteenth Report of the Regents of the Uni-*

These Contributions are principally the results of investigations ıring the years 1861 and 1862, and comprise 226 pages of text, elve excellent lithographic plates and numerous woodcuts, coverfollowing subjects:

Descriptions of [37] new species of Brachiopoda, from the Upper ·erg, Hamilton and Chemung groups,—being mostly extracted e fourth volume of the *Paleontology of New York.*

)bservations upon some of the Brachiopoda, with reference to the ;rs of the genera Cryptonella, Centronella, Meristella, Trematosıynchospira, Retzia, Leptocœlia and allied forms.—A part of this ppeared in the *Transactions of the Albany Institute* of February l was copied into the September number of this *Journal.*

)bservations upon the genus Streptorhynchus, with remarks upon ecies heretofore referred to Strophomena and Orthis.

Note on the Geological Range of the genus Receptaculites in an Paleozoic strata,—tracing the genus from one species in the , limestone, and four in the Galena, to three in the Niagara group, he Lower Helderberg, and one in the Schoharie grit.

Note on the occurrence of Astylospongia in the Lower Helderberg

)n the occurrence of Crustacean remains, of the genera Ceratiocaris hyrocaris; with a notice of some new species from the Hamilton nd the Genesee slate (with one plate).

Observations upon some spiral-growing fucoidal remains of the ic rocks of New York (with one plate),—referring to the new genus yton the indistinct Devonian forms heretofore known as *Fucoides Galli, F. Velum,* &c.—The author infers, from the fact of the nce of these forms, so far as now known, solely in Devonian rocks, ;ir occurrence may be found of advantage elsewhere, as indicating

strata of similar age, but adds: "In other regions, however, where the line between Devonian and Carboniferous is not so well defined as in New York and to the westward, these forms may be found to have a greater vertical range; and I have not at present evidence for asserting that they do not occur in the Lower Carboniferous shales of Pennsylvania."

(8.) Observations upon the genera Uphantænia and Dictyophyton; with notices of some species from the Chemung group of New York, and the Waverly sandstone of Ohio (with four plates).—We extract the closing remark: "Within New York these fossils are restricted to the Chemung group; and their occurrence in Ohio, in rocks below the conglomerate, has always been regarded by me as strong evidence of the equivalency of the formations. The paucity of species of fossils in the Ohio rocks identical with those of New York has lately furnished an argument against the equivalency of age of these formations; with what force, I leave geologists to decide. These same doctrines, carried out in their application to other formations, would decide all the *sedimentary groups* of the Mississippi valley to be distinct from those of New York. The requirement of specific identity among marine fossils to determine geological equivalency can never be fulfilled when sedimentary formations are studied over wide geographical areas."

(9.) The Flora of the Devonian period.—After some general observations on the subject, a recent article by Dr. Dawson (*Quart. Journ. Geol. Soc.*, xviii, 296) is here reproduced. In the introductory observations, Prof. Hall discusses the geographical distribution of Devonian and Carboniferous plant-bearing beds, and shows that during the Devonian age the dry land must have been confined to the northern and northeastern portion of the area, whence drifted the fragmentary specimens which are found in the rocks of the central portions of the continent; also, that during the Carboniferous age, though the land extended farther southward, its exposure was not for so long a period, and that the northern portion produced a far larger quantity of vegetation, while the extreme southwest produced almost or quite none, the formations of the age there consisting of limestones. A few remarks are added upon the Catskill group, the *exact* demarcation of which, however, if it has any real existence, is not yet understood.

(10.) Preliminary notice of the Fauna of the Potsdam sandstone; with remarks upon the previously known species of fossils, and descriptions of some new ones, from the sandstones of the Upper Mississippi valley (with five plates).—This article, comprising 91 pages, has also been issued in separate form (see below). The title, at first glance, leads us to expect a review of all described species, but in fact the eastern species, with one exception, are omitted, the reason stated for which is (see pages 184, 210) that few have been described from the *typical* sandstone, most species referred to this age being from calcareous or shaly layers whose exact position is still in question. As this is but a preliminary notice, we may hope that a thorough revision of the whole subject will ere long make its appearance. The author suggests a doubt (page 125) as to the generic identity of the forms referred to the modern genus *Lingula*. This article contains descriptions of 3 new species of Dicellocephalus (Dikelocephalus

is written by Owen), 11 of Conocephalites, besides the species before known; and also four new genera of Trilobites—*Ptychaspis* for the *D. Miniscaensis* and *granulosus* of Owen, and *Chariocephalus*, *Illænurus*, and *Aglaspis* for other hitherto unknown forms. In addition, there are species of Arionellus, Triarthrus (new subgenus Triarthrella) and Agnostus. A supplementary note describes two other new species of Arionellus, and also the interior casts of what seem to be pygidia of a new Crustacean; they are convex and trilobed, with only the narrow middle lobe transversely sutured, the lateral being broad and smooth; it is called *Pemphigaspis bullata.* Professor Hall observes with regard to the distribution of the species of the Upper Mississippi valley:

"Although I have not been able to recognize the successive Trilobite beds of the Sandstone as indicated by Dr. Owen, I can nevertheless refer the species here described to three different epochs in the Potsdam period; and I am not prepared at the present time to suggest any farther subdivision. In the lower beds of the formation I have found Conocephalites proper, together with Lingula, Lingulepis, Obolella? and Theca. In the middle stage, neither the limits of the beds, nor the range of species or genera, have been so well determined; but grouping together all that I have found between the well-defined upper beds and the lower fossiliferous beds known, we have Conocephalites, Dicellocephalus, Arionellus, Ptychaspis, Chariocephalus, Illænurus and Agnostus, in the trilobitic fauna, together with Orthis and Platyceras. The Graptolitidæ apparently begin their existence somewhere in this central epoch, but their precise relations to the other beds have not been determined. In the higher beds of the formation, and clearly separated from the great central mass, we have the Genera Dicellocephalus, Triarthrella and Aglaspis, together with Lingula, Serpulites and Euomphalus. We observe, therefore, that the earliest trilobites are referable to the genus Conocephalites; and the genus Dicellocephalus does not appear in the first stages of the formation, nor below the beds which I have referred to the second or middle stage of the period. There this genus appears in three species, smaller and less conspicuous than those in the higher beds. It is only in the later stages of the sandstone, that the typical species of this genus of Dr. Owen appear; and those from the lower beds, thus referred by him, belong apparently to other genera." * * *

"Notwithstanding the successive stages recognized, the physical conditions have been very monotonous throughout the entire period; and in the character of the fauna there are similar indications. We find great numbers of individuals of one species; and although recognizing very distinctly numerous species, there is a kind of uniformity of character and monotony of expression, never equalled by so many species in any formation of equal thickness; or even of much less thickness, where consisting of varied character and conditions of deposit. The multitude of individuals of a few species is really wonderful; for in some beds the layers may be separated at every inch, or even half-inch, and yet the entire surface is covered with the dismembered parts of these ancient trilobites."

[We may here remark that the spelling *Dikelocephalus*, although it is that of Owen, the author of the genus, is wrong, and no authority can

make right a continuation in the error. The word is from the Greek δικελλα and κεφαλη, and therefore requires two letters *l*; and, also, if the *k* of the second part be changed into *c*, (as it should be,) the *k* of the first part ought also to be so changed. The true orthography is therefore *Dicellocephalus*.—EDS.]

(11.) Notes and Corrections,—under which head, observations are made on Retzia and Lichas.

2. *Preliminary Notice of the Fauna of the Potsdam sandstone, or Lower sandstone of the Upper Mississippi valley. With a letter to M. Joachim Barrande*; by JAMES HALL. Albany, Nov. 15th, 1863. 8vo, pp. 91, with six plates.—With the exception of the introductory letter to Mr. Barrande, this is simply an extract from the aforementioned Regents' Report, in connection with which it is noticed.

3. *Preliminary Notice of some species of Crinoidea from the Waverly sandstone series of Summit County, Ohio, supposed to be of the age of the Chemung group of New York*; by JAMES HALL. Published at Albany, November 11, 1863. 8vo. pp. 11.—This paper, published in advance from the 17th Report on the New York State Cabinet, contains descriptions of sixteen new species of Crinoids, whose relations are partly with species from the western Subcarboniferous limestones, but principally with those of the Hamilton and Chemung groups of New York. The author expresses the hope, which we beg leave to heartily indorse, that this notice may induce explorers to examine other localities on the same horizon.

4. *A Monograph of the Fossil Estheriæ*; by T. RUPERT JONES, F.G.S., Prof. Geol. and Min., Royal Military College, Sandhurst. 134 pp., 4to, with 5 plates. London, 1863. Printed for the Paleontographical Society.—Prof. Jones has long made the Estheriæ a special study, and is high authority on all that pertains to them. The memoir contains detailed descriptions of the known species, illustrated by figures. Some of the results arrived at by the author are mentioned on page 277 of vol. xxxvi, of this Journal.

VI. ASTRONOMY AND METEOROLOGY.

1. *On the new Planet Eurynome* (79), (in a letter to the Editors from Prof. JAMES C. WATSON, dated Observatory, Ann Arbor, Nov. 12, 1863). —In the ephemeris of the new planet discovered Sept. 14, which I sent you, there is an error in the place computed for Nov. 7th, which affects the positions assigned by the ephemeris for a few days preceding and following that date. The following is a continuation of the ephemeris computed from the same elements, and for the purpose of indicating the correct predicted place for Nov. 7th, I commence it with that date.

The planet is to be called *Eurynome.*

Ephemeris of *Eurynome* (79) for Greenwich Mean Noon.

	α	δ	log. Δ.
1863, Nov. 7	$0^h\ 28^m\ 29^s$	$+3°\ 18'·3$	0·04202
11	28 3	3 1 ·0	0·05174
15	28 10	2 47 ·7	0·06222
19	28 48	2 38 ·6	0·07328
23	29 58	2 33 ·6	0·08483
27	31 38	2 32 ·6	0·09674

	α	δ	log. Δ.
1863, Dec. 1	0h 33m 47s	2° 35′·4	0·10884
5	36 25	2 41 ·9	0·12112
9	39 29	2 52 ·0	0·13349
13	42 58	3 5 ·3	0·14589
17	46 52	3 21 ·7	0·15821
21	51 8	3 40 ·9	0·17048
25	0 55 44	+4 2 ·7	0·18255

The correction to be applied to this ephemeris, Nov. 11th, was

$$\Delta\alpha = +4^s \qquad \Delta\delta = +0'\cdot3.$$

This agreement is very close, considering the fact that the elements were derived from observations made during only the nine days following the date of the discovery.

On several evenings I have made careful estimates of the magnitude of the planet by comparing it with stars of nearly the same brilliancy in its vicinity, and adopting Argelander's scale.

Date.	Mag.	Date.	Mag.
Sept. 14,	9·50	Oct. 12,	9·50
26,	9·50	23,	9·20
28,	9·50	28,	9·25
Oct. 10,	9·25	31,	9·25
11,	9·50	Nov. 3,	9·20

Reducing these estimates to Oct. 10th, and taking the mean, giving the estimates equal weights, we find,

Oct. 10th, magnitude = 9·3.

According to the elements already obtained, adopting this determination for Oct. 10th, the mean opposition magnitude of the planet, M = 10·37, and the magnitude when the planet is in opposition will vary between the limits 9·0 and 11·4.

The planet therefore ranks among the brighter members of the Asteroid Group, and it is probable that the final determination will indicate that it is brighter than results as above.

METEOROLOGY—

2. *Shooting Stars on the night of November 13th–14th,* 1863.—Quite extensive arrangements were made this year for watching for shooting stars on the nights near Nov. 13th. A circular was issued by the Committee on Meteors of the Connecticut Academy, and one by Mr. Robert Brown, Jr., of Cincinnati, inviting the coöperation of observers. These invitations were heartily responded to throughout the country. The former arranged for observations on one night, Nov. 13–14th, the latter on three successive nights. The reported results are very gratifying. They show distinctly that there was a larger number of meteors to be seen Nov. 13–14th than on ordinary nights, and also than have been seen on the corresponding night of years immediately preceding. A radiation from Leo is also very distinctly shown. Unfortunately, at nearly every station whose latitude is greater than that of New York, the clouds and rain prevented successful observation. The following is a brief account of observations made.

(1.) Lieut. Gilliss, of the U. S. Naval Observatory at Washington, communicates to the editors of this Journal observations on 213 shooting

stars seen by Mr. Ferguson, Assistant Astronomer, Professors Hall and Harkness, and Messrs. Springer, Eastman, Rogers and Harrison, on the night of Nov. 13–14th, 1863. The duration of flight was in each case estimated, the places of appearance and disappearance, and the apparent magnitude. The observations will be published in detail. The average of the estimates of duration is 0·37 sec. In this list there were—

From	$10^h\ 10^m$	to	11^h,	8	meteors.
"	11	"	12	11	"
"	12	"	1	23	"
"	1	"	2	42	"
"	2	"	3	46	"
"	3	"	4	46	"
"	4	"	$5^h\ 7^m$	37	"

(2.) At Haverford College, Prof. Samuel J. Gummere, assisted by Prof. Clement L. Smith, Messrs. James A. Chase, Edward T. Brown, R. Barney Taber, Allen C. Thomas and R. Morris Gummere, saw 316 shooting stars between $10^h\ 38^m$ P. M. and $5^h\ 16^m$ A. M. of the same night. The distribution of the flights through the hours was as follows.

From	$10^h\ 38^m$	to	11^h P. M.	6	meteors.
"	11 33	"	12	10	"
"	12	"	1 A. M.	40	"
"	1	"	2	52	"
"	2	"	3	67	"
"	3	"	4	69	"
"	4	"	5	64	"
"	5	"	5 16^m,	8	"

Nearly two hundred were located upon the chart, and the lines show a decided radiation from the sickle in Leo.

About seventy of them were among those seen at the Naval Observatory in Washington. The paths of more than fifty can probably be computed.

(3.) Mr. B. V. Marsh, at Germantown, watched from 1^h to $5^h\ 20^m$ A.M. Mr. Philip H. Strubing assisted in keeping the record. Mr. Marsh saw

from	1^h	to	2^h	17	shooting stars.
"	2	"	3	20	"
"	3	"	4	26	"
"	4	"	5	20	"
"	5	"	5 20^m	14	"
Total in $4^h\ 20^m$,				97	"

There were no clouds, but the air was hazy and stars near the horizon were invisible. The time lost in making the record was estimated at not less than 15 per cent. This gives 26 per hour for one observer.

About seven-eighths radiated from the sickle in Leo, or from near ε Leonis. One or two left lasting trains, one being visible at least 45 seconds.

(4.) Mr. H. D. Vail, assisted by Mr. Wm. G. Rhoads and Mr. Thos. H. McCollin, observed at Philadelphia. They recorded 55 paths, 15 or 20 of which appear to have been seen at Washington. Mr. C. J. Allen of

Philadelphia reports the apparent paths of six meteors of the first magnitude.

(5.) Mr. Benj. Hoopes, of Westchester, Pa., sends 56 observed paths, many of which were of meteors also seen in Washington.

(6.) At Easton, Pa., Messrs. E. Menline, Chas. Sitgreaves, and A. F. Beckdolt observed 27 paths.

(7.) To the North and East of these stations the clouds and rain prevented observation almost entirely. Rev. H. S. Osborn, at Belvidere, N. J., saw three. Homer G. Newton, M.D., and Mr. T. W. Twining, at Brooklyn, saw six. At New Haven, Prof. W. D. Whitney, A. W. Wright, Ph.D., J. W. Gibbs, and Mr. Hewitt, with a large party of students, were watching and saw only 32 from $9\frac{1}{2}^h$ P. M. to $1\frac{1}{2}^h$ A. M. The air was very hazy, and after half past one the sky was entirely covered. The paths traced after eleven o'clock indicate a radiation from Leo.

A party of six persons went from New Haven to Hartford, but we were able to see only imperfectly for two hours in the evening. Hon. J. H. Trumbull was watching with us. Sixteen meteors were seen between $9\frac{1}{2}^h$ and $11\frac{1}{2}^h$ P. M. Most of the time Polaris was scarcely visible through the haze. After half past eleven P. M., not a star was to be seen during the night.

Two only of these sixteen meteors were observed at New Haven. One at $9^h\ 30^m$ was first seen at an altitude of 57 English statute miles, and disappeared at an altitude of 49 miles. The length of path was 21 miles, and its estimated duration of flight three-fourths of a second. The other, at $9^h\ 43^m$, appeared at an altitude of 65 miles, and disappeared at an altitude of 30 miles, its course being nearly vertical. The estimated duration of flight was 2 seconds. Neither of these could have belonged to the November group. The velocities are 28 and 18 miles per second respectively.

(8.) Capt. C. E. Dutton, at Norfolk, Va., began to observe at 3^h A. M. of the same night, with an assistant. Both looked to the constellation Leo, and they saw during the first hour 36 meteors, most of them very small. The paths of all but four, if traced back, would pass through the region bounded by the sickle in Leo. During the next half hour they looked in opposite directions, and saw in that period 43 meteors.

(9.) J. H. Worrall, Ph.D., at West Chester, Pa., watched alone in the open air on the four mornings from Nov. 11th to Nov. 14th. The following are the numbers seen. On each morning, except the second, he watched two hours, on that morning an hour and a half.

	Nov. 11th.	Nov. 12th.	Nov. 13th.	Nov. 14th.
From $3^h\ 45^m$ to $4^h\ 45^m$,	12	3	10	30
" 4 45 " 5 45	5	1	12	19
Hourly average,	8·5	2·7	11	24·5

On the first morning the sky within 25° or 30° of the horizon was obscured by the haze. The star δ Ursæ Minoris was clearly visible. On the second morning the sky was a little more obscured. The third morning the above named star was just discernible. The haze was not so thick on the fourth morning. On the morning of Nov. 15th it rained.

(10.) Mr. Francis Bradley, of Chicago, Ill., says that "on the night of Nov. 12–13th it was cloudy until midnight, and our company of observers

dispersed. At 2 o'clock, A. M., Nov. 13th, I arose and found it partially clear, few or no stars being visible below an altitude of 30° or 40°. The rest of the sky was a little dim. Up to 3 o'clock I saw *three* flights, from 3 to 4 o'clock *two*, and from 4 to 5 o'clock only *four*. Among the whole only 3 or 4 were conformable. There was not apparently the usual number seen. Undoubtedly the haziness obscured some, as there were almost as many impressions of flights as I counted of meteors actually seen. There would seem to have been not the slightest indication of an approaching shower. The following three or four nights were cloudy and rainy."

(11.) Prof. O. N. Stoddard, of Miami University, at Oxford, Ohio, aided by a number of members of the Senior Class, observed on the nights of Nov. 11th and Nov. 12th. The next night was cloudy. The following are the numbers seen:

	10^h to 11^h	11^h to 12^h	12^h to 1^h	1^h to 2^h	2^h to 3^h
Nov. 11–12th,	16	19	28	20	22
" 12–13th,	10	36	40	43	—

Of those seen the first night, 67 were conformable, or 64 per cent. On the second night 76 were conformable, or 59 per cent. There were seen in the N.E. 44, in the S.E. 41, in the S.W. 45, in the N.W. 70, and in the zenith 34. During the first night the southern part of the heavens was partially obscured several times for a few minutes by light fleecy clouds. The larger number seen the second night cannot however be entirely explained by the greater clearness of the atmosphere.

(12.) At St. Louis, a party under charge of Prof. Chauvenet succeeded in mapping 23 paths between half past eight and half past ten, P. M., Nov. 13th. The sky which had before been partially obscured then became entirely covered with clouds.

(13.) Mr. Robert Brown, Jr., of Cincinnati, Ohio, arranged for an extended series of observations and invited assistance from observers at other places. He proposed to watch for a certain number of hours on three consecutive nights, from Nov. 11th to Nov. 14th. Although the third night was cloudy at some stations, Mr. Brown reports very gratifying success. Observations were made at the following stations by parties under the direction of the professors named.

At Oxford, Ohio,	by Prof. O. N. Stoddard.
" Hillsborough, Ohio,	" Prof. Matthews and Messrs. Edwards and McKibben.
" Marietta, "	" Prof. Evans.
" Pittsburgh, Pa.,	" Profs. Woods, Burnham and Bradley.
" Bloomington, Ind.,	" Profs. Wylie and Kirkwood.
" College Hill, Ohio,	" Prof. Tuckerman.
" Richmond, Ind.,	" Profs. Morgan and Moore.
" Gambier, Ohio,	" Prof. Hamilton L. Smith.
" Frankfort, Ind.,	" Mr. J. B. Rence.
" Nashville, Tenn.,	" Rev. J. Berrien Lindsley, D.D.
" Louisville, Ky.,	" E. A. Grant, LL.D.
" Cardington, Ohio,	" Mr. M. Allen Armstrong.
" New Albany, Ind.,	" E. S. Crosier, M.D., U. S. A.
" Crawfordsville, "	" Prof. J. L. Campbell,
" Hanover, "	" Prof. S. H. Thomson,
" Cincinnati, Ohio,	" Messrs. Robt. Brown, Jr. and C. G. Boemer.

(14.) The following observers have reported that they were prepared) watch on the night of Nov. 13th, either alone or with others; viz., rof. J. D. Everett, Windsor, N. S., Mr. E. W. Morley, Andover, Mass., Ir. Horace Bumstead, Boston, Mr. F. W. Russell, Natick, Mass., Mr. Esty, mherst, Mass., Mr. R. Norman Foster, Northampton, Mass., Mr. Hiram . Cutting, Lunenberg., Vt., Mr. Searle, Newport, R. I., Rev. Wilder mith, Berlin, Conn., Mr. G. W. Hough, at the Albany Observatory, obert Van Arsdale, Esq., Newark, N. J., Mr. C. S. Woodward, Ypsilanti, lich., Prof. James C. Watson, Ann Arbor, Mich., Mr. A. F. Bandelier, r., Highland, Ill., Mr. I. A. Lapham, Milwaukee, Wis.

It is probable that the denser portion of the November flock is of no reat thickness, and that the earth passes through it in a few hours. If o, the display of meteors in great numbers could not be seen in the same ear in all parts of the earth. Moreover, if the shower comes on successive years the region of maximum display should move each year a little more than six hours in longitude westward, since the annual period is between six and seven hours more than an even number of days. In 1832 there was a display in Europe; in 1833 one in America. Yet the ame shower should evidently be visible through several hours (not less han six) in longitude.

According to the observations this year there appears to have been a ecline of numbers towards morning. We should naturally expect an icrease until daybreak, since their frequency it would seem should be roportional to the sine of the angle of elevation of the radiant. If the lecrease is real and is due to a diminution of the numbers entering he atmosphere, we may conclude that the longitude of the maximum lisplay is less than 5 hours west of Greenwich. Possibly the European bservations this year will decide this point.

It is well worth observing whether there is a four years period for any single longitude, as might be expected from a ring of small thickness. If we are to have in 1866 a return of the display of 1833 there is some reason to suppose that it will be more remarkable in Europe than in America. H. A. N.

Additional Communications.—After the foregoing abstract by Professor Newton was in type, full Reports were received from Prof. A. D. Bache, Superintendent of the Coast Survey, and from Prof. Hamilton L. Smith, of Kenyon College.

The Coast Survey observations were made on the 13th–14th, at a locality in Washington (lat. 38° 52′ 58″, long. 76° 59′ 32″), by a corps under direction of Mr. Charles A. Schott, Assistant of Coast Survey, and composed of himself with Mr. L. F. Pourtales, Assistant Coast Survey, and Messrs. J. Main, A. Zumbrock, W. T. Bright, L. Karcher, J. Downes, and H. Main,—eight observers,—and to each certain portion of the heavens two observers were generally assigned. Magnitudes were noted, and also the instants of flight to the nearest half second on a chronometer of known error and rate, and with a free command of the heavens down o 15° above the horizon, which was beclouded. The durations of flight were recorded in forty-nine instances. From 8 P. M., Nov. 13, to 2 A. M., Nov. 14, one hundred and seven flights were recorded and more than half of them mapped upon the star chart as follows:—

From	8^h	to	9^h	7 meteors.	From	11^h	to	12^h	14 meteors.
"	9	"	10	8 "	"	12	"	1	31 "
"	10	"	11	11 "	"	1	"	2	36 "

At $10^m\ 51\frac{1}{2}^s$ after midnight, and also at $11^m\ 30\frac{1}{2}^s$, large and splendid meteors, the first from 5° N.E. of Sirius and the second from 3° E. of the same, moved west 60°, in the first instance, and 50° in the next, both nearly parallel to the equator, and the last directly across Sirius.

The durations varied from $0^s{\cdot}1$ to $1^s{\cdot}00$, and they average $0^s{\cdot}41$ for the forty-nine estimated.

At Kenyon College the night of the 13th–14th was entirely obscured, and that of the 12th–13th partially. There were, however, in 331 minutes after $10^h\ 20^m$ P. M., one hundred and ninety-nine meteors seen, viz: N.E. 36, N.W. 35, S.E. 58, S.W. 17, N. 1, E. 7, Zenith 43, S. 2. On the night previous (11th–12th), in 210 minutes, from $11^h\ 22^m$ P. M., to about $2^h\ 52^m$ A. M., one hundred and eighty-five meteors were seen, viz: N.E. 50, N.W. 21, S.E. 68, S.W. 24, N. 3, E. 4, Zenith 15. The magnitudes were noted, and also the instants of flight, and, in numerous instances, the duration. The last varied from $0^s{\cdot}25$ to $1^s{\cdot}50$, but their average requires further inquiry and examination. Many of the flights are mapped on the chart, and these vary in arc from 2° to 25°. One of the longest lies in Perseus and remarkably exhibits a continuous curve, having its termination about at right angles to its beginning.

Both of these Reports will be treated more in detail hereafter, when the entire mass of returns shall have been collated and discussed. A. C. T.

VII. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Expedition to the Desert of Sahara under Messrs. Martins and Escher von Linth.*—Through the kindness of a friend we are enabled to give the following information relating to an expedition now in progress from Switzerland to the Sahara desert, under the direction of Messrs. Martins and Escher von Linth.

The expedition left Switzerland on the 11th of October last and reached Algiers on the 18th. From there, they went to Philippeville and Constantine, and thence started for Batna and Biskara, and were at the latter place on the 22d of November. They were to take camels at Biskara and journey for many days over the desert. Their chief object is to ascertain whether the great desert was the former bed of an ancient sea.

On reaching the "Col de Spa," "a kind of embrazure in the last chain of mountains to the north of Biskara," they came at once in sight of the endless Sahara. The letter observes:

"They also, like the French soldiers twenty years ago, and the Roman Legions seventeen centuries before, could not help crying, '*the sea, the sea*,' transported as they were by the impression of the immensity of the tableaux. Another solemn moment of their journey was the passage of the 'cluse' of El Kantara, where, after a long walk in a most barren and desert country, they perceived also, on a sudden, the Oasis of Biskara delineating itself in the most delightful manner with its palm-trees loaded with their gilded fruits. The contrast between the icy solitude of St. *Gothard* and the lovely gardens of Lago Maggiore is certainly striking,

but it is far less complete and especially less sudden than that which they witnessed from El Kantara."

"In the Oasis of Biskara they met the finest of weather, 17° C. (=62½° Fahr.) in the shade. The little hotel where they alighted is surrounded by a garden as fine and as green as in Switzerland in the month of July—the fig, mulberry, and pomegranate trees retaining still all their leaves which do not at all appear to be willing to fall yet. The vine still forms dense hedges, hanging full of enormous late grapes, and the pomegranate trees bend under the weight of their heavy fruits."

2. *Mount Hope Nurseries, Rochester, N. Y.*—In vol. xxxiii, p. 430, was published a short notice of Bonapartea juncea. The prospect of maturing some seeds was there mentioned. This proved to be reality. Near the upper part of the stem, seeds were found which, on being planted, germinated, and a few days since I saw there three young plants of the Bonapartea flourishing finely.

The head of the old plant slowly decayed, a part of the leaves fell off, no suckers or shoots have appeared, and by another summer the plant will have died.

It is now known, if not ascertained before, that the seeds of this plant will ripen in a warmed conservatory.

Many and splendid additions of exotics have been made by the proprietors. The air-plants, *Tillandsia pulchella* and *linifolia*, were in full bloom a few weeks since, growing upon a dry stick a few inches long, besides others of the Orchis family. C. D.

Rochester, N. Y., Sept. 1, 1863.

3. *The Chemical Chair in Berlin*, made vacant by the lamented death of Mitscherlich, has been declined by Bunsen, who could not be induced to leave the circle of friends he has drawn about him in Heidelberg. Dr. Hofmann, of London, has since received the proffer of the place, but he it is said also hesitates, feeling himself, if he should conclude to leave London, under obligations to go to Bonn, where they have offered to place $100,000 at his disposal to organize a laboratory and school of science. It will be a matter of surprise if he is tempted to leave London for either place.

4. *Prof. Watson's new Asteroid* (79) *Eurynome*, was independently observed also by Temple at Marseilles on the 3d or 4th of October, at Leipsic on the 4th of Oct., and at Vienna Oct. 6th, which observations are published in *Astr. Nachtr.*, Nos. 1440 and 1441. Prof. Watson's observations from Sept. 14 to Sept. 23 at Ann Arbor, are given in *Astr. Nachtr.*, No. 1442, and in this Journal for November, 443. See also this number, p. 140.

5. Prof. Ogden N. Rood.—Prof. Rood, formerly of Troy University, and well known by his numerous able physical papers in this Journal, has lately been elected to the Chair of Physics in Columbia College, New York, and will enter upon his new duties at once.

Book Notices.—

1. *A Text-book of Geology;* designed for Schools and Academies, by James D. Dana. 356 pp. 12mo. Illustrated by 375 wood-cuts. 1864. Philadelphia, Theodore Bliss & Co. Price $1.75.

In the preparation of the Text-book the general plan of the "Manual

of Geology" has been followed. Geology has been treated as a *history*,—a history of the geographical changes of the globe, or those of its continents and seas, through the successive ages, and also a history of the progress of life from the earliest species to Man; and the illustrations of the science have been mainly drawn from American rocks, so that the work, while a general treatise, is eminently a geological history of the American continent.

Although an abridgment of the "Manual," it is not a patchwork of extracts from it. The whole has been entirely rewritten and thrown into a new form, in order to adapt it to its special purpose and give it the unity of an independent work. It covers the same broad ground with the larger volume, exhibiting like comprehensive views of the science; but the facts and principles are presented in a briefer manner and a more simple style, and at the same time with full illustrations by means of sections, views, and figures of fossils.

The work is intended to meet the wants of schools, academies, and other literary institutions, and not less those of the general reader who would obtain a knowledge of geology without entering into its many details.

2. *A Tract on Crystallography, designed for the use of students in the University;* by W. H. Miller, M.A., For. Sec. R.S., F.G.S., etc. 86 pp. 8vo. Cambridge, 1863.—This volume is properly an introduction to Prof. Miller's system of Crystallography, and will be welcomed by all students of his system. It contains an investigation of the formulæ for crystallographic calculations used in his method, together with some additional theorems on the general properties of crystalline forms.

3. *Descriptions of the Fossil plants collected by Mr. George Gibbs,* Geologist to the U. S. Northwest Boundary Commission under Mr. A. Campbell, U. S. Commissioner; by Dr. J. S. Newberry. (From the Boston Jour. N. Hist., vol. vii.)—The plants here described were collected on Vancouver's Island, Orcas Island, and at Bellingham Bay, etc., on the coast of Washington Territory; and those of the first mentioned locality, including *Aspidium Kennedyi* N., a *Sabal*, undescribed, *Taxodium cuneatum* N., *Populus rhomboidea* Lsqx., and *Ficus? cuneatus* N., are from the Cretaceous, and perhaps also those of Orcas Island.

4. *Reminiscences of Amherst College,* Historical, Scientific, Biographical and Autobiographical, &c.; by Edward Hitchcock. Northampton, Bridgemain & Childs, 1863. 12mo, pp. 412. 4 plates and a map of the Geology around Amherst College.—It was fit that the venerable ex-President of Amherst College should, as the closing labor of his long and laborious life spent in the service of education and science, record his personal reminiscences of the institution with which his name and fame are inseparably connected. The book is a reflex of the man—full of simple, almost childlike, earnestness, concealing nothing, not even his personal expenses. The reader sees without disguise all the springs and machinery by which, with admirable skill and patience, a well endowed and prosperous institution has been made to rise from the *res angustæ domi,* almost *res adversæ,* of its unpromising beginnings. What Dr. Hitchcock has done for science in connection with the inception and growth of its various departments in Amherst is here made apparent, not by any boast-

ful or self-laudatory statements, but inferentially from the simple thread of history.

On another occasion we may return to this volume for some valuable statistics of the scientific departments at Amherst. A full list of Dr. Hitchcock's numerous publications is given, amounting in all to no less than 171, of which 24 are distinct volumes and 60 are on scientific subjects.

5. *Frick's Physical Technics.*[1]—We cordially commend this book to all teachers of physics and especially to those whose situation or circumstances cut them off from access to a good collection of physical instruments. The arrangement of the book follows Müller's text book, many of the figures of apparatus being identical. While the most expert demonstrator may gain some useful hints from Dr. Frick's book, the less experienced teacher and student will find it an invaluable vade mecum in the physical laboratory. It is beautifully printed on tinted paper and Dr. Easter's translation is thoroughly good English.

6. *Waitz's Introduction to Anthropology*, translated from vol. I of the *Anthropologie der Naturvolker*, by J. T. Collingwood, F.G.S., F.R.S.L., and published for the Anthropological Society of London by Longman, Green, Longmans and Roberts.—This work sustains the idea of the unity of the human race. We have not yet seen a copy of it, but learn from the notices of it by reviewers that differ from the author in his conclusions, that it is a work of profound learning and thoroughness, and great fairness and philosophical acumen in the treatment of the subject.

7. *Petroleum vein in Northwestern Virginia;* by J. P. Lesley. (From the Proc. Amer. Philos. Soc., vol. ix, 1863.)

OBITUARY.

Henry Fitz.—The death of Mr. Henry Fitz has inflicted an almost irreparable loss upon that large class of scientific men whose apparatus is the product of the optician's skill, while those who knew him personally and appreciated his frank and generous character must feel that his vacant place cannot be filled.

It is not saying too much to assert that Mr. Fitz has done more to popularize Astronomy in this country than any other man. In former days good telescopes were only to be had by importation from Munich, at a cost and delay which amounted to a prohibition. Mr. Fitz, bringing to bear a rare mechanical skill, a wonderful ingenuity, and a hopeful enthusiasm which no obstacles could resist, placed within reach, at a moderate cost, instruments of fine optical quality, while his practical and cheap equatorial mounting gave to every observer the advantages which were hitherto enjoyed only in fixed observatories with costly instruments.

Mr. Fitz was entirely a self-taught optician, and like his friend and co-worker, Mr. Clark, of Cambridge, was indebted solely to his own ingenuity and reasoning powers for all his methods and manipulations. It is a

[1] Physical Technics; or Practical instructions for making experiments in Physics and the construction of Physical Apparatus with the most limited means. By Dr. J. Frick, Director of the High School in Freiburg, and Professor of Physics in the Lyceum. Translated by John D. Easter, Ph.D., Professor of Natural Philosophy and Chemistry in the University of Georgia. Philadelphia: J. B. Lippincott & Co., 1862. 8vo, pp. 467.

little remarkable that both of these American opticians were many years since independently conducted by their investigations to the method of local correction for optical surfaces; a method described lately in the French Academy by M. Leon Foucault, as a new discovery of his own, which he claims to be of the greatest importance to practical optics. It is not intended to impugn the originality of Mr. Foucault's discovery, but simply to record the priority of American invention—it is within the knowledge of the writer that Mr. Fitz used the method of local correction as early as the year 1846.

The largest telescope completed by Mr. Fitz was of the dialitic construction, having an aperture of 16 inches. It is mounted in the private observatory of Mr. Van Duzee, of Buffalo.

The principle achromatic telescopes made by Mr. Fitz are located as follows:

One of	13	inches	aperture at	Alleghany City, Penn.
" "	13	"	"	Dudley Observatory, Albany, N. Y.
" "	12	"	"	Ann Arbor, Michigan.
" "	12	"	"	(not yet mounted) at the Vassar College, Poughkeepsie, N. Y.
" "	11$\frac{3}{8}$	"	"	the private Observatory of Mr. L. M. Rutherfurd, New York City.
" "	10	"	"	U. S. Military Academy, West Point.
" "	9$\frac{3}{4}$	"	"	private Observatory of Mr. Vickars, Baltimore.
" "	9	"	"	belonging to the Hon. Mr. Letsome, British Chargé to Monte Video.
" "	8$\frac{3}{4}$	"	"	Elmira Female College, N. Y.
" "	8	"	"	Haverford College, Penn.
" "	8	"	"	private Observatory of Mr. John Campbell, New York City.
" "	6$\frac{1}{2}$	"	"	constructed for the U. S. Astr. Expedition to Chili, and now there.
" "	6$\frac{1}{2}$	"	"	private Observatory of Mr. Robert Van Arsdale, Newark, N. J.

Mr. Fitz's optical labors were not confined to the production of telescopes, but almost immediately upon the announcement of the discoveries of Daguerre and St. Victor, he constructed cameras, and was, I believe, the first to produce a camera capable of working in a practical time for portraits.

At the time of his death he had just perfected a view lens of great merit, which compares most favorably with the justly celebrated globe lens of Harrison & Schnitzer.

Within the compass of a short notice it would be impossible to enumerate all the instrumental additions and simplifications for which the scientific world is indebted to Mr. Fitz, and perhaps it would not be in the power of any one person to recall them all: they could only be gathered from a comparison of the experience of those who knew and reaped the benefit of his fertile ingenuity, the achievements of which were rarely alluded to in his modest and unostentatious conversation.

Mr. Fitz has left with his bereaved family precious legacies of experience and material which it is hoped will enable them to continue his optical labors in a worthy manner.

PROF. E. EMMONS.—Died, at his plantation, in Brunswick, N. C., October 1st, 1863, Professor EBENEZER EMMONS, M.D. Born in Middlefield, Mass., in 1798, he was graduated at Williams College in the class of 1818. He studied medicine and received the degree of M.D. from the Berkshire Medical School in 1830. In his Alma Mater he was Professor of Natural History from 1833 to 1859, and was then appointed to the chair of Mineralogy and Geology. While a member of college, his studies were directed towards the departments of natural science by attending the lectures of Prof. Amos Eaton, who then began that course of lecturing and teaching by which so many hundreds of young men were made active lovers of natural history, an era in which this science had its beginning in our country. When the geological survey of the state of New York was commenced, Dr. Emmons was appointed one of the *four* geologists between whom the State was divided into four great sections; and to him was assigned the N.E. portion of the State on the coast of Lake Ontario and south to the counties of Herkimer, Lewis and Saratoga, as the divisions were in 1842, when his report was published. Dr. Emmons removed from his home in Massachusetts to Albany, that he might be in the centre of the great geological survey. There he was made a Professor in one of the chairs of the Albany Medical College. To his Geological Report, he added successive reports on the agriculture of the State. At length he was appointrd to the Geological Survey of North Carolina by its Governor. He prosecuted that survey with great industry and success, and made several important discoveries of unknown fossils of animals; and becoming interested in some lands, he removed his family there, the more easily to complete the survey. There the rebellion found him, and he was not permitted to return to the north. There his life was closed. On his exhibition of his fossil collections in North Carolina, at the meeting of the Scientific Association at Albany in 1856, Professor Agassiz stated that the discoveries were of a higher character in geology than any published for years.

The offices Dr. Emmons held show the public estimate of his qualifications and acquisitions. His labors show that this estimate was not too high or misplaced.

In his Report on the Second (his) District of New York, which before his examination was unknown as to its geology, Dr. Emmons gave a lucid and full view of the rocks and their relations, and chapter VII and the two following contain his "Taconic System," or the rocks between the fossiliferous of Eastern New York and the primary rocks of the western part of New England. In the Report on the Agriculture of the State, published in 1843, Dr. Emmons gave an expanded and interesting view of the Taconic System. Though opposed by some of his associated geologists and by some others of high distinction, the author has found support in some distinguished geologists of Europe. Dr. Emmons died as he had lived, an honest man, a warm hearted friend, a loyal citizen, and an humble and consistent christian. C. D.

VIII. WORKS RECEIVED.

PROCEEDINGS OF SOCIETIES.—

Jahresbericht über die Fortschritte der Chemie; herausgegeben von HERMANN KOPP and HEINRICH WILL. Für 1861.

Oversigt over det kongelige danske videnskabernes Selskabs Forhandlinger og dets Medlemmers Arbeider i Aaret 1861.

Jahrbücher des Vereins für Naturkunde im Herzogthum Nassau. Sechszehntes Heft. Wiesbaden: 1861.

Verhandlungen der naturforschenden Gesellschaft in Basel. Dritter Theil. Viertes oder Schluss-heft. Basel: 1863.

Zeitschrift der Deutschen geologischen Gesellschaft. XIV. Band. 2. Heft. 1862. Berlin: 1862.

Monatsberichte der königlichen Preufs. Akademie der Wissenchaften zu Berlin. Aus dem Jahre 1862. Mit 11 Tafeln. Berlin: 1863.

Bulletin de la Société Impériale des Naturalistes de Moscou, publié sous la Rédaction du Docteur RENARD. Année 1862. Nos. II, III, IV. Moscow: 1862.

Verslagen en Mededeelingen der koninklijke Akademie van Wetenschappen. Afdeeling Naturkunde. 3d and 4th parts. Amsterdam: 1862.

Verslagen en Mededeelingen der koninklijke Akademie van Wetenschappen. Afdeeling Letterkunde. 6th Deel. Amsterdam: 1862.

Jaarboek van de Koninklijke Akademie van Wetenschappen. Gevestigd te Amsterdam, voor 1861. Amsterdam.

Bulletins de L'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. 31me Année, 2me Sér., T. XIII, XIV. 1862. Bruxelles.

Mémoires Couronnés et autres Mémoires, publiés par l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique. Collection in-8°.—T. XIII, XIV. Bruxelles: 1862.

Jahrbuch der kaiserlich-königlichen geologischen Reichsanstalt. 1861 und 1862. XII. Band. Nro. 3, 4. The same, 1863. XIII. Band. Nro. 1, 2.

REPORTS.—

Report of the Commissioners upon the Troy and Greenfield Railroad, and Hoosac Tunnel. February 28, 1863. Boston: Wright & Potter, State Printers, No. 4 Spring Lane. 1863.

Seventy-Fifth Annual Report of the Regents of the University of the State of New York. Albany: 1862.

Report of the Commissioner of Agriculture for the year 1862. Washington: 1863.

Report of the Commissioner of Patents for the year 1861. Agriculture. Washington: 1862.

METEOROLOGY AND ASTRONOMY.—

Meteorological Observations made at Providence, R. I., extending over a period of twenty-eight years and a half, from December, 1831, to May, 1860. By ALEXIS CASWELL, Professor of Natural Philosophy and Astronomy in Brown University, Providence, Rhode Island. Washington City: Published by the Smithsonian Institution, in the Smithsonian Contributions to Knowledge. October, 1860. New York: D. Appleton & Co.

Discussion of the Magnetic and Meteorological Observations made at the Girard College Observatory, Philadelphia, in 1840, 1841, 1842, 1843, 1844, and 1845. Second Section, comprising Parts IV, V, and VI. Horizontal Force. By A. D. Bache. Published by the Smithsonian Institution. November, 1862. New York: D. Appleton & Co.

Report upon the determination of the Longitude of America and Europe from the Solar Eclipse of July 28, 1851. By Professor Benjamin Peirce, LL.D., &c. &c.

New Discussion of the Distribution of the Magnetic Declination on the Coast of the Gulf of Mexico, with a Chart of the Isogonic Curves for 1860. By Assistant CHARLES A. SCHOTT.

Standard Places of Fundamental Stars. U. S. Coast Survey.

Sur la Marche annuelle du Thermomètre et du Baromètre en Neérlande et en divers lieux de L'Europe, déduite d'observations simultanées de 1849 à 1859.

Par C. H. D. BUYS BALLOT. Publiées par L'Académie Royale des Sciences à Amsterdam. Amsterdam: 1861.

Abstracts of Magnetical Observations made at the Magnetical Observatory, Toronto, Canada West, during the years 1856 to 1862, inclusive, and during parts of the years 1853, 1854, and 1855. Toronto: 1863.

Reduction of the Observations of the Deep-Sunk Thermometers at the Royal Observatory, Greenwich, from 1846 to 1859. By Prof. J. D. EVERETT, of King's College, Windsor, Nova Scotia. Extracted from the Greenwich Observations, 1860.

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[SECOND SERIES.]

III.—*The Classification of Animals based on the principle halization;* by JAMES D. DANA.—No. III. *Classification ·bivores.*[1]

›rinciple of cephalization and its applications rest on the g simple facts:

ʟn animal is embodied or concentred force, which force s polarity in the results of its action in development, that e oppositeness of the anterior and posterior extremities tructures evolved and also in the dorso-ventral relations structures.

'he *primary* potential centre is in the head, or more pre- n the cephalic nervous mass—an animal being funda- y a cephalized organism. But, besides this, there may ›r more *secondary* centres.

ʾpecies differ (*a*) in the amount of force concentred; ɩe degree of control of the systemic force over vegetative and development; (*c*) in the distribution of the force he principal (or fore-and-aft) axis—that is, in its being rated mainly anteriorly, or diffused, to a greater or less from the cephalic extremity posteriorly toward the cau- 'emity or pole.

ľhe differences just mentioned are expressed in the struc- the organism; and all such expressions are necessarily ˌons of grade.

ˈach of these kinds of differences must have expression, pparent, (*a*) through the various circumstances attending

[1] rticle I, see the last volume of this Journal (vol. xxxvi), pp. 315, 440; and ɜ II, this volume, p. 10.

development or growth, and (*b*) through all the steps in the progress of growth, as well as (*c*) in the resulting structures.

The above general facts are at the foundation of all the methods of cephalization, or decephalization, pointed out in Article I. They receive further illustration in the pages beyond, and special explanations on pages 175 to 182.

This subject of cephalization throws new light, as has been shown, on the limits and gradal distinctions of groups. The characteristics which it affords, like all others appealed to in classification, cannot overrule affinities based on obvious resemblances in type of structure. Their object or use, on the contrary, is rather to exhibit the affiliations and distinctions of types by presenting new views of their relations and making manifest the true basis of all affinities. Between different types of structure there is generally a difference of grade, which is evinced in characters that indicate different degrees of cephalization.

It follows from the nature of the principle that both high and low cephalization, although *opposites*, should often lead to *similar* results; as, for example, to abbreviations anteriorly and posteriorly in animals generally—to memberless abdomens in Crustaceans—to small wings in Insects, etc. (Art. I, pp. 337, 440). This evolving of approximately like results from the opposite extremes of cephalization is one source of the difficulties in the subject of classification. But the law cannot, on account of the trouble it may give, be condemned; for, as I have before remarked, it is in accordance with universal truth that smallness, or circumferential contraction, should proceed both from concentration, and from lack of quantity, although these are opposite conditions. The difficulties in the way of a right use of the principle of cephalization are, therefore, in nature, and must be met by the only legitimate means—thorough study.

Many errors in the attempts to present to view the system of nature have arisen from confounding cases that, as above explained, are widely diverse. The writer would not claim to be always right in his own interpretations; for he is well aware that far profounder knowledge is requisite for unfailing accuracy. But he believes that the principle appealed to is right and fundamental; and if he ventures to present new classifications of departments in zoology in which adepts in these departments have made trials with diffierent results, it is only to offer such illustrations of the principle in view as will serve to exhibit the methods of its application and its various bearings.

In the first article on this subject, after explanations of the general subject of cephalization, the higher subdivisions of the animal kingdom were considered. In the second, one of the *Orders* was reviewed and an arrangement given of its subdivisions, down to the grade of Tribes. In the present, the classification of a *Tribe* is followed out, down to the grade of Families.

Classification of Herbivores.

Under the order of Megasthenes,[1] the tribe of Quadrumanes, as stated on p. 334, Art. I, is properly *hypertypic*, that of Carnivores *superior typical*, that of Herbivores *inferior typical*, and that of Mutilates (or Cetaceans) *hypotypic*.

1. *Distinctions between Herbivores and the tribes next superior and inferior.*

A. Herbivores show their inferiority to Carnivores, or the superior typical group of megasthenic Mammals, on the basis of the principle of cephalization, in the following ways:

(1.) In the fore-limbs being defunctionated of the power of prehension and reduced to simple locomotive organs.

(2.) In the fore-limbs being not as much superior to the hind-limbs in strength as in the Carnivores, and even inferior to the hind-limbs in some species,—Herbivores, being less strongly *prosthenic* than Carnivores, and the species of the larger and most characteristic group being *metasthenic*.

(3.) In the structure being strongly amplificate.—Taking the Lion as the standard of size for the highest grade of life among typical Megasthenes, the Elephant—certainly inferior in type, and, therefore, also in degree or quality of systemic force—exhibits inferiority likewise in its great bulk; it is a marked example of a *gross-amplificate* structure. Hogs and the related species are no less gross-amplificate, but on a feebler life-system. Again, the Horse and also all Ruminants are *long-amplificate*, as appears strikingly in their lengthened limbs, especially the extremities of the limbs, and, also, in the neck and body.

(4.) In the head being prolonged or amplificate.—Even the Elephant is here no exception; for the great tusks and trunk correspond to an elongation of the head extremity, their development being at the expense of the jaws and of part of the teeth. In the Horse, the facial part of the skull is four times as long as the cranial portion. (See p. 165.)

[1] In order that the position of Herbivores, as recognized by the writer, may be clearly understood by the reader, I repeat here the arrangement of the higher divisions of Mammals proposed in the number of this Journal for January, 1863, (vol. xxxv, p. 65), presenting the tribes of Megasthenes and Microsthenes, as before, in parallel columns in order to exhibit their parallel relations.

Order I. Man.

Order II. Megasthenes.	Order III. Microsthenes.
1. Quadrumanes.	1. Chiropters or Bats.
2. Carnivores.	2. Insectivores.
3. Herbivores.	3. Rodents.
4. Mutilates.	4. Edentates.

Order IV. Oötocoids.

Marsupials and Monotremes.

(7.) In the extremely wide variations as to size and shape under the type, and the occurrence of bizarre features.—As, for example, (1) in the existence of horns on the forehead or nose; (2) in the nose being prolonged into a proboscis; (3) in the teeth being sometimes elongated into tusks which have the size and function of horns, and might be called *jaw-horns;* (4) in the limbs and neck having sometimes extravagant length; (5) in abnormal growths on the body, as in the hump of the Camel and the Brahmin Ox, the dewlaps of Oxen, etc.

(8.) In the forehead, in very many species, being perverted to serve for defense or attack; and the nose sometimes for prehension, digging, etc., as well as defense.

(9.) In the typical species being elliptic as regards one or more of the four types of teeth in one jaw or both, this deficiency in the dental series being a characteristic of the type; also in a void interval in the series of teeth between the molars and canines in the same typical species.

(10.) In being prematurative in development, the young animal having the power of sight and locomotion almost as soon as born.

The abnormal outgrowths from the body or skeleton of Herbivores—as of horns on the forehead or nose, of a proboscis by an elongation of the nose, of tusks, horn-like in function, by an elongation of teeth, of humps of fat as in the Camel—serve to show, and even, if possible, more strikingly than the tendency to amplificate structures, that the vegetative force in Herbivores is far less under systemic control than in Carnivores. The Carnivores may be styled a *tight* type, the Herbivores remarkably a *loose* one. Stepping over the line from Carnivores to Herbivores is passing from a group of marked regularity to one full of abnormities.

B.—The superiority of the urosthenic aquatic Herbivores (Sirenians) to the Mutilates (Cetaceans) is exhibited in their—

(1.) Having the nostrils never defunctionated, nor perverted to blowholes, these organs being essentially like those of terrestrial Mammals.

(2.) Never being multiplicate as to the number of phalanges, or joints, of the digits.

(3.) Never being multiplicate as to the teeth.

(4.) Never being so elementalized as to the teeth that the distinction into the different types (molars, etc.) is lost (Mutilates, like Reptiles, having the teeth all of a kind).

(5.) Having the *primary* potential centre (p. 157) never abnormally remote from the anterior extremity.

Some species of Cetaceans (Balænæ and Physeters) have, like the Limulus among Crustaceans, one-third to one-half of the length of the body anterior to the base of the jaws, so that

the primary centre (or that of the brain) is very remote from the anterior extremity—thus approximating to the position it has in the Radiates, and showing a low grade of decephalization. See on this point, Art. I, p. 328, and beyond, p. 179.

Mutilates consequently differ from aquatic Herbivores fundamentally in (*a*) being *multiplicate* structures, as manifested in their limbs and teeth, as well as in the less important fact of great length of body behind; and also (*b*) in being more *elementalized* structures, as shown in the reptile-like teeth. The type is eminently, therefore, a multiplicate and elementalized type, and thus stands apart from that of the Sirenians.[3]

2. *Prosthenic, metasthenic and urosthenic distinctions among Herbivores.*—The distinctions, *prosthenic, metasthenic* and *urosthenic* appear to be an important basis of subdivisions under the Herbivorous type.

The *urosthenic* species (or those using the caudal extremity for locomotion) are the *Sirenians*, as the Dugong and Manatus.

The distinction of *prosthenic* and *metasthenic* is manifested among the other Herbivores in two ways: (1) a higher or *primary*, in the general structure; and (2) an inferior or *secondary*, in the extremities of the limbs.

(1.) *In the general structure.*—Under this method, the *prosthenic* species are those in which the fore-limbs are the stronger pair, and the *metasthenic*, those in which the hind-limbs are the stronger. The *former* include the Proboscideans, Rhinoceroses, Tapirs, Hogs and Hippopotamids. The Hog is particularly strong in the neck and fore-quarters. It is well known that a fatted hog often loses the use of its hind-limbs from overgrowth, and not of the fore-limbs, although the fore-limbs carry not only their share of a body nearly equally divided between the limbs, but also the heavily weighted head.

The *metasthenic* species are the Solipeds and the Ruminants, in which the hind-limbs are well known to be the strong pair. The Horse and Camelopard use their hind-limbs for self-defense, and so do also, to some extent, many of the Ruminants. Among the large Mammals, strength in the posterior limbs is an essential requisite for a draught-animal; and not less so for a mountain-climber, especially when the fore-limbs are not prehensile; and, consequently, nearly all the larger mountain-climbing animals, frequenting precipitous heights, are species of Ruminants.[4]

[3] This definition excludes not only the Sirenians but also the Zeuglodonts, which have been shown to be Carnivores, with normal teeth and nostrils, although very elongate in body and *urosthenic*.

[4] For a draught-animal something more is needed than mere strength of hind-limbs, and consequently all of these metasthenic species are not good for this kind of service. There may be too great length of limb,—too little real strength for the long and steady pull which it requires, and which is very different from the mere

Such species, strong in the hind-limbs, are well named *Sthenomeres* (from the Greek *σθενος strong* and *μηρος thigh*).

(2.) *In the extremities of the limbs.*—The sthenic distinction referred to under this head is the inferior of the two because it appears only in the *extremities* of those organs which in their general relations exhibit the former. The manifestation of it is confined to the hand and foot.

As the inner side of the hand or foot is the more central side in the system and the outer the more circumferential—a fact which any one will become aware of on looking at his open hand as it lies on a table—the higher species should have the principal strength in the inner fingers rather than the outer. The transfer of force from the innermost to the outer, with descending grade of species, is well exemplified among Herbivores and the higher Mammals.

In Man the *inner* toe is the strongest, and the order of strength is that of the toes, or 1, 2, 3, 4, 5. It is the same also in the hand. In the Gorilla it is the same for the foot, and for the hand there is only this difference that 1 and 2 are about equal. In the inferior Quadrumanes and the superior Carnivores the *third* is the strongest as well as largest digit, and in many Carnivores the first in the hinder pair is obsolescent. In the inferior Carnivores, as the Plantigrades, the *third* and *fourth* digits are often about equal, and the *fifth* as strong as the *second:* thus in *Ursus Americanus* (as figured in Blainville's *Osteologie*) 4=3, and 5=2; in *U. arctos* (*ferox*) 2, 3, 4, 5 are very nearly equal; in *U. labiatus* 4 and 5 are *the longest*, exceeding 3; in species of *Nasua* 4=3 and 5=2; in the *Cercoleptes* or kinkajou, one of the lowest of Carnivores, 4 *is a little longer than* 3 and 5 *than* 2; in *Gulo luscus* 4=3; in the Mustelids, *Lutra vulgaris* and *Mustela Foina*, 4=3, or 3 is scarcely the longer; in the Viverrids 3 is generally slightly longer than 4, but in the inferior aberrant species *Eupleres Goudotii* and *Bassaris astula* 4=3 and 5=2. These species are therefore essentially *paridigitate*, except that the first digit is present. Thus there is an outward diffusion of force in descending from Man to the lower Carnivores.

Under Herbivores, the higher species have the *third* toe the longest—or, they are *imparidigitate*, as these kinds are usually styled. Thus it is with the Proboscideans, Rhinoceroses and Tapirs, and it is so *whether the number of toes be three or four*, that is whether *even or odd in number*.

In the inferior Herbivores the force is still more circumferentially diffused; for the *fourth* digit is equal to, and sometimes

movement of the legs demanded of a beast of burden,—too little superiority in the posterior to the anterior limbs, or an ill-adjustment of muscles and lungs, etc., for the purpose. The Camel, one of the hypotypic or degradational Ruminants, is a case here included.

even stronger than, the *third;* and, at the same time, the *fifth* is as strong as, or stronger than, the *second*, if both are not altogether wanting; while the *first* is obsolete. The examples include all the so-called *paradigitate* species, as the Hog, Stag, Ox, etc., in which the toes are equal (or approximately so) in pairs, the larger pair consisting of the *third* and *fourth* toes, and the other, of the *second* and *fifth*. In the common Ox, the *fourth* toe appears to exceed slightly the *third* in size, and so also, the rudimentary *fifth* the *second*. In the Hog, also, the *fourth* toe is sometimes a little the largest.

This sthenic distinction partially fails among degradational forms, such as the Seals, Sirenians and Cetaceans, in which the structure is so far degenerated that this delicate mark of grade has not its full normal exhibition.

3. *Distinction depending on the existence, or not, of a power-organ to aid in feeding, additional to those of the jaws.*—Carnivores have, as one of their characteristics, organs apart from the teeth to aid in seizing or gathering their food. Among Herbivores, the Elephant has an organ of prehension of great power and perfection in the trunk or elongated nose. The Tapirs and Hogs have also an elongated nose, which, although incapable of prehension, except to a slight degree in the former, is a power-organ essential to the animal for the collection of its food. The Rhinoceros has a nose-horn serving in the same way. The nose is thus in all these groups, from the Elephant to the lowest of the Suids or Hog-group, not merely a nose, but an organ of special power and use for obtaining the food of the animal; and the species might be described in a word as *Sthenorhines* (from the Greek *σθενος strong* and *ῥις nose*).

The Horses and the Ruminants feed themselves by grazing, using their lips, teeth and tongue for the purpose, but having no aid from the nose.

4. *Distinction of gross-amplificate and long-amplificate.*—*Gross-amplification* consists in a general enlargement of the structure beyond the type-size for a given amount of systemic force, and does not necessarily imply a change in the relative sizes of the parts, or in their proportions. It may be manifested both in the skeleton and in its fleshy covering; and when in the latter it is often apparent in the production of an abnormal amount of fat over the body. This fatty overgrowth is the lowest grade of gross-amplification.

Long-amplification is exhibited in an increased proportional length of the body and its limbs or members, involving in Vertebrates an elongation of the bony structure.

The *gross-amplificate* terrestrial Herbivores are those of the Elephant, Tapir and Hog groups, in which there is little difference in the proportions of the body from those of the Carnivores.

The *humerus*, for example, bears approximately the same proportion in length to the *radius* and to the whole limb, and also to the neck, in the Elephant, Rhinoceros, Hog and Hippopotamus as it does in the Carnivore. The length of head is increased in each of these groups by an amplificate snout—as remarked on the preceding page; but this is in part a *fleshy* elongation; and it is sometimes increased also by means of a horn, but only an *epidermic* horn. The bony-structure of the head has an elongation beyond that characteristic of the lower Carnivores; but it is independent of any in the limbs.

The Bovine species are examples of gross-amplification on a *long-amplificate* structure.

The *long-amplificate* species include all the Ruminants, together with the Solipeds or species of the Horse-family among the Non-ruminants.

This long-amplification is exhibited prominently in the *limbs*, *neck* and *head*.

(1.) *In the limbs.*—As in other cases, it is manifested most strikingly toward the circumferential limits of the system. The humerus shows no elongation, and is often even shorter, as compared with the size of the body, in these amplificate species than in more typical kinds. Below the humerus, amplification is apparent in the fact that the radius exceeds in length the humerus; it is still more manifest in the great elongation of the bones below, especially the metacarpals and phalanges, the former alone being sometimes as long as the radius. The same general facts are true of the hind-limb. Owing to this extension of the extremities, the joint which seems like the knee in the leg of a Horse, Deer, Ox, etc. is really the commencement of the foot. In the fore-limb of a Horse, the humerus is hardly *one-fourth* the whole length of the limb; the radius is nearly *a fourth* longer than the humerus; and the cannon-bone is *two-thirds* as long as the radius. In the Camel the proportions are not very different; the radius is relatively a little longer, and the cannon-bone as much shorter. In the Camelopard the humerus is but a little more than *one-fifth* of the whole limb (measured, as in the Horse, from the commencement of the humerus to the extremity of the digits); the radius is *one-half* longer than the humerus; and the cannon-bone, or metacarpal, is *as long as* the radius. The facts strongly contrast with those among the Elephant, Tapir and Hog groups, the humerus in these species being between *one-third* and *four-ninths* of the length of the whole limb, and longer than the radius.

It would seem, therefore, that *the length of the humerus in the long-amplificate species may be taken as an approximate indication of the true type-size, or as a standard from which to measure the degree of amplification of the structure.* Still, I see no positive

proof that the humerus is not here shortened in compensation for the lengthening below.

(2.) *In the neck.*—No one will question the fact of a long-amplification of the neck and head in these species. It is however difficult to find a proper standard of length for definite comparisons. There is some special interest in the relations to the length of the humerus, and I therefore mention these relations, as has been done in the comparisons between the parts of the limbs.

In the species of Felis, the neck is not longer than the humerus; in the gross-amplificate Herbivores, as the Rhinoceros, and Hippopotamus, the same is true; but in the long-amplificate species, a very different relation exists. In the Horse the neck is *twice* the length of the humerus; in the Camel nearly *three times;* in the Camelopard over *three times.*

(3.) *In the head.*—The outer or more circumferential portion of the jaws, corresponding to the incisors and canines, pushes out, under this amplification, far away from the more basal or molar portion, making the void space between quite wide, much wider than in the Rhinoceros and Tapir. Referring to the humerus as a standard of length, as above, the cranium in the genus Felis, measured from the extremity of the jaws to the occiput, is from *four-fifths* to *once* this unit; in the Rhinoceros, *one and one-fourth,* to *one and one-third;* in the Horse, nearly *twice;* in the Camel, *one and one-third;* in the Camelopard, *one and a half.* The ratio for the Camelopard and Camel does not exhibit the true condition, because both species are cephalically vastly inferior animals to the horse and therefore have unusually small heads for the size of the animal. The Camelopard shows the long-amplification of its head in the narrow proportion of the skull, and the long void space in the jaws. This aberrant Ruminant is built, not only in its long legs and neck but also in its little elongate head, on the type of a Grallatorial or Wading bird.

This amplification or circumferential extension of the head appears in many species to be concurrent with that in the limbs, as if the two were of like dynamical origin, or had a dependent genetic relation in the structure.

Long-amplification in the head is still further exhibited in the typical Ruminants through an outgrowth of horns on the forehead. This is a frontal elongation, bony in its nature (or having a bony core at least), and peculiar to these *long-amplificate* species. In other words, those species in which the bones of the limbs grow long have generally long growths of horn from the forehead.

5. *Subdivisions in the classification of Herbivores.*—The distinctions which have been mentioned on the preceding pages point to the same general arrangement of the terrestrial Herbivores.

Two grand divisions are indicated.

I. The *Elephant*, *Tapir* and *Hog* groups are alike in being—

(1.) Prosthenic in general structure.

(2.) Gross-amplificate; rarely long-amplificate in the limbs.

(3.) Not amplificate in the forehead through an outgrowth of bony horns—the only horns being nasal, and these epidermic.

(4.) Amplificate in the snout, there being, in addition to the anterior elongation of the cranium, a fleshy elongation, or sometimes an epidermic horn.

(5.) STHENORHINES, the elongate snout being a power-organ for aid in feeding, etc.

II. The *Solipeds* and *Ruminants*, on the contrary, are—

(1.) Metasthenic in general structure, and, therefore, STHENOMERES.

(2.) Long-amplificate in the limbs, neck and head, and sometimes, *in addition*, gross-amplificate.

(3.) Long-amplificate in the forehead through an outgrowth of horns, except in the superior group of Solipeds and the inferior or hypotypic species.

(4.) Not amplificate in the fleshy part of the snout.

(5.) Not Sthenorhines—having no use for the nose but the legitimate one.

The two groups are then—

I. The Prosthenics, or STHENORHINES, including the Elephant, Tapir and Hog groups.

II. The Metasthenics, or STHENOMERES, including the Solipeds and Ruminants.

The species of the Hog-group and Tapir-group are closely related, in general form; in their short limbs; in the long and powerful and, thereby, *working* snout; in their teeth approximating to those of the Carnivores; and in the omnivorous character or tendency of some species. And the relation of the Tapirs to the Elephant-group is no less striking. These affiliations have been generally admitted by zoologists. The species of the Tapir and Hog groups, especially the latter, are the most Carnivore-like of Herbivores.

So, among the Sthenomeres, the living Ruminants have by all been associated in classification. The Solipeds alone have been arranged in most systems with the Pachyderms. But these are metasthenic like the Ruminants, being the strongest of Sthenomeres and the most valuable of draught-animals; they are grazing animals, like the Ruminants, and have no rooting nose; they have the same great length to the void interval on the jaw between the molar and the other teeth; and they have similar long-amplificate limbs. While, then, the Horse has undeniable

relations to the Pachyderms, it has close affinities also to the Ruminants. It is a *Sthenomere* and not a Sthenorhine; but it stands in the group of Sthenomeres, between the Ruminants and the Sthenorhines,[a] representing a Pachydermatoid division in the group.

The prosthenic species, it appears, are the *gross-amplificate*, and the metasthenic are the *long-amplificate*. But this distinction in amplification is not of that fundamental nature which would lead to its being an exclusive feature of either type; and yet the exceptions to its being so are remarkably few. In the *gross-amplificate* group, or that of the *Sthenorhines*, the *Macrauchenia*, if a Tapiridean (see p. 172), is one exception—the species having, according to Owen, a long neck, nearly as in the Llamas. The extinct *Paleotheres* are other exceptions; for in these Eocene associates of the Anoplotheres the metacarpals and metatarsals have about the elongation of those of the *Anoplotheres*. All the long-amplificate Sthenorhines are *extinct species* (p. 183).

The distinction of prosthenic and metasthenic observed in the *extremities* of the limbs, or the digits, which has given rise to the subdivision into *Imparidigitates* and *Paridigitates*, affords an indication of grade *under* the above two grand divisions—the paridigitate species being the inferior. Thus the Hog-group (paridigitate) stands below the Tapir-group (imparidigitate), and is, hence, at the foot of the *Sthenorhines;* and the Horse-group (imparidigitate) is at the head of the *Sthenomeres*. As this distinction is inferior in sthenic value to that of prosthenic and metasthenic manifested in the general structure (pp. 161, 162), it cannot properly be made the basis of the *principal* grand divisions of Herbivores, as proposed by Owen, unless all such sthenic characters are overruled by fundamental resemblances in type, which is here not the case; the type-resemblances bear the other way, and not to a separation of the Hogs and Tapirs, nor to a union in one group of the Hogs and Ruminants.

The existence in Paridigitates of two horns, one either side of the front, is mentioned by Owen as an example of *pairs* in these species, additional to that in the toes; and the occurrence in the Imparidigitates of a horn (or horns) only on the medial line of the front as an additional case in these Herbivores of an *odd* organ. This *odd* horn occurs only in the Rhinoceroses among the Imparidigitates, and on a *medial* organ, the nose; and with so small a range of facts to sustain the deduction, we may reasonably doubt the alleged connection between the odd or

[a] It may also be here repeated that the Horse is related to the Ruminants in not having a *decidua* developed,—a *decidua*, as stated by Huxley, characterizing the higher Megasthenes, from Man through the Quadrumanes and Carnivores to the higher Herbivores (the Elephant and Hyrax, at least); but not the species of the Hog-group, the lowest of Sthenorhines, nor any of the Sthenomeres. (See Art. II, p. 13).

even in horns and the odd or even in the toes. The true distinction with regard to the horns appears to be that already mentioned:—that the Sthenorhines have only the *nose*—not the forehead—elongated or amplificated through a growth of horns, and this is an epidermic amplification, while among the Sthenomeres, an inferior group, the bony structure of the *forehead* is long-amplificate.

If it be sustained that the Camelopard has a central horn on the front of the head, as has been claimed and recently reaffirmed, a case of an odd or medial horn occurs among the *Paridigitates*; but it is a forehead-horn.

We should therefore make the statement thus:

The Sthenorhines, *gross*-amplificate species, may have one or two *nasal epidermic* horns, or *horns proceeding from the exoskeleton*.

The Sthenomeres, *long*-amplificate species, may have two or more *frontal bony* horns, or *horns proceeding from the endoskeleton*. In addition, the exoskeleton, under this inferior type, sometimes contributes large epidermic additions in the shape of sheaths to the horns, as well as hoofs to the feet.

III. The *third* group of Herbivores includes only the *Sirenians*—aquatic species that fail of hind-limbs, like Whales, but bear various marks of superiority to the Mutilates, as already briefly indicated.

The grand divisions of the tribe of Herbivores, which have been pointed out and elucidated in the preceding pages, are indicated in the following Synopsis, together with the subdivisions to which we appear to be led by the further application of the principle of cephalization. In connection, one or two of the more prominent distinctions of the higher groups are mentioned.

Synopsis of the proposed classification of Herbivores.

I. Sthenorhines.

Prosthenic. Snout serving as a power-organ, usually elongated. Gross-amplificate, rarely long-amplificate in extinct species. Horns, when any, proceeding from the exoskeleton alone, nasal.

1. Proboscideans.—Snout an organ of digital as well as brachial prehension. Imparidigitate.

(1.) Elephantids.
(2.) Dinotherids. (?)

2. Tapirideans.—Snout imperfectly, or not at all, prehensile, there never being prehension at the extremity (or digital prehension). Imparidigitate.

(1.) **Rhinocerotids.—Having a nasal horn.**

(2.) Tapiroids.—Without a nasal horn. Snout elongate, often imperfectly prehensile.

a. Tapirids.
b. Paleotherids.

(3.) Hyracids.—Without a nasal horn. Snout not elongated.

3. SUIDEANS.—Snout elongate, but not at all prehensile. Paridigitate.

(1.) Suids.
(2.) Hippopotamids.

II. Sthenomeres.

Metasthenic. Long-amplificate, even when gross-amplificate. Snout not a power-organ. Horns, when any, proceeding from the endoskeleton, frontal.

1. SOLIPEDS.—Without horns. Imparidigitate.

(1.) Equids.
(2.) Macrauchenids. (?)

2. RUMINANTS.—Having horns in the typical group, except often in females. Paridigitate.

(1.) Cornigers.—Having horns. Frontiferient.

a. Cervids.
b. Antilopids.
c. Camelopardalids.

(2.) Nudifronts.—Without horns. Not frontiferient, feeble in self-defense.

a. Camelids.
b. Moschids.
c. Anoplotherids.

3. ——————?

III. Sirenians.

Urosthenic, natatorial. Having a large caudal fin for swimming. Posterior limbs wanting.

Manatus, Halicore or Dugong, Rytina, etc.

In the following enumeration of the distinctions of the several subdivisions, I confine myself almost entirely to those characteristics which are obviously based on the principle of cephalization, omitting the many anatomical details to be found in zoological treatises.

A. *Subdivisions of the Sthenorhines.*

(1.) The *Proboscideans* are distinguished by the high characteristic of having in the proboscis a prehensile organ of great

power and perfection—one that combines the qualities both of a prehensile hand and a grasping arm, and which, therefore, is more serviceable for prehension than the fore-limb of a Carnivore. Although this is a perverted use of a nose, it is not supposed to be attended with any degeneration of the normal sense below that of other Herbivores. The elliptic condition of the jaws in the species is connected, as already explained (Art. I, p. 400), with the enormous development of the tusks. The forelimb is proportionally as short as in the Lion, and the hand-portion even shorter, its length being only *one-half* that of the humerus.

The Dinothere appears to show in its skull that it was a true Proboscidean, that is, an animal with an Elephant-like proboscis. If so, it was, in all probability, a terrestrial animal, like an Elephant, or not more aquatic than a Hippopotamus. The fact that prehension is a characteristic of Carnivores and the higher Mammals, and, among terrestrial Herbivores, only of the superior species, indicates that it is a mark of high grade, and, therefore, one that is not likely to be associated in such perfection as that of the Elephant with the structure of an aquatic natatorial Herbivore.

(2.) The *Tapirideans* are related to the Proboscideans in the snout, and to the Suideans in this and many other characteristics. Unlike the latter, they are imparidigitate, the third finger being the longest. The cranium is considerably elongated, being from one-half to two-thirds longer than the humerus, and thus diverges widely from the same in the Carnivores.

The family of the Rhinocerotids is distinguished by the greatly thickened nasal bones and the nasal horn, and by the snout not being at all prehensile. The joints of the fore-limb in the *Rhinoceros Javanus* have very nearly the same proportional length as in the higher Carnivores; but the cranium as compared with the length of the humerus is one-third longer.

The Tapiroids have the snout prolonged, and often, if not always, somewhat prehensile, the prehension being brachial in kind and not digital; and the fore-limbs have the outer or *fifth* toe well developed, while the inner or *first* is wanting, thus showing inferiority (according to the principle stated on page 162) both to the Rhinoceros (3-toed) and Elephant (5-toed), in each of which the toes are nearly balanced either side of the *third*. In one division of the Rhinoceros group, including the extinct species made into the genus Acerotherium by Kaup, the toes of the fore-limbs are four in number, as in the Tapir, and besides this the horn is absent; and if, as suggested by Blainville, the so-called Acerotheres are only females, there is no question that this extra outside toe without a first is, among the imparidigitate Herbivores, a mark of inferiority, as argued on page 162. The same conclusion might be drawn, though less safely, from the fact that these

Acerotheres (whether females or not) are among the earliest geological representatives of the Rhinoceros group.

The Hyracids are degradational forms, having the snout not prolonged and not horned, yet having it terminate in a flat naked space with the nostrils on either side, also having the tail reduced to a mere tubercle, and having the small size, as well as some of the habits, of a Rodent of the Hare family. It is good at digging. This abbreviation before and behind in the Hyrax may be an example under the *elliptic* method of decephalization, evincing feebleness in a life-system which is of extreme smallness for the Herbivore-type. The animals of the little Syrian species were long since described as "a feeble folk." (Prov. 30 : 26).

3. The *Suideans* are generally acknowledged to be far more closely related to the Tapiroids than to the other Paridigitates (or Ruminants). Yet they bear many evidences of inferiority to that group. Besides being paridigitate, they have the jaws more amplificate than in the Tapirs, as appears in the fact that the extremity, bearing the incisors and canines, is more remote from the molar portions, and still more strikingly, in many species, in the canines being elongated into tusks, and the incisors also being sometimes large and spaced out. This amplificate condition reaches its extreme in the Hippopotamus. There is also a great tendency to gross-amplification through the development of fat—the lowest kind of amplification. Another hypotypic feature is the graceless and bizarre forms of many species. Still another is the abnormal reverted growth of the upper canines, which, in one species, the Babyroussa, pass out through the facial part of the skull, becoming long curving nasal horns. Still another evidence of inferiority is the very small size of the brain compared with that of the head.

The Hippopotamids are extreme examples among Pachyderms of gross-amplificate structures, and are evidently hypotypic species in this hypotypic group. They manifest this in their size, grossness of head and body, aspect of deformity in every part, soldered radius and ulna, and in their being the most aquatic of the group. Their unusually short legs and spread toes, also, are evidently marks of inferiority; for in a system so low in structure throughout, these peculiarities cannot be a consequence of high cephalization. It is a step toward the Mutilates.

B. *Subdivisions of the Sthenomeres.*

1. The *Solipeds* rank the Ruminants, not only because imparidigitate, but also, because of their higher grade of digestive system, and the bare forehead; for in these species absence of horns appears to be a mark of elevation. That they are the highest of Sthenomeres is also evident from the elegance of form,

grace of motion, fleetness and strength which characterize one or more species of the group, and which combination of qualities is presented in equal perfection in no other Herbivore. The type, therefore, may rightly claim the first place in its grand division, and not a subordinate one, either between Tapirs and Rhinoceroses or Hogs, or below Goats and Oxen.

The Macrauchenia, according to Owen, was much like a Ruminant in its *legs*, although *imparidigitate*, and near the Camel in its *neck*, while it had *probably* (the head is yet unknown) no Tapir-like proboscis. The radius and ulna were united, and so also the tibia and fibula. Its place in the system may be, therefore, along side of the Equids, or the imparidigitate Sthenomeres. If, however, the animal had a proboscis, the species would fall among the Tapirideans and represent an inferior long-amplificate subdivision. The term *Solipeds* or *Solidungulates*, might well be replaced by *Equideans*, as the existence of a *solitary* hoofed toe is not an essential characteristic of the group.

2. The *Ruminants* are naturally divided into two groups.—

(1.) The *Cornigers* or typical species.—These are (*a*) furnished with horns (whence the name applied to them) at least in the males. They are (*b*) *frontiferient*, that is, strike with the forehead in attack. (*c*.) The foot has great compactness, the two principal toes (normally the *third* and *fourth*) being so large, and so well hoofed, that the animal walks upon them; the hoofs are flat on the inner side and fit well together, so as to look and act much like one cloven hoof. (*d*.) The two posterior toes (*second* and *fifth*) are too short to touch the ground, and are sometimes altogether wanting. (*e*.) Two metacarpals, and also two metatarsals, are, with a rare exception, coalesced into a single "cannon-bone"; also, the scaphoid and cuboid bones, at the base of the cannon-bone, are united. These particular characters are here enumerated in order to exhibit the contrast between this type and that of the Nudifronts.

The two families of Cervids and Antilopids, mentioned in the Synopsis, page 169, are the same in limits as those usually so named, except that the Camelopard is excluded. The Camelopardalid is the special long-amplificate, or Heron-like group, under the Corniger type. The horns are persistent, as in the Antilopids; but instead of a corneous sheath, they have for a covering only the hairy skin. In this respect and, further, in their extreme long-amplification, in the young animal's having horns at birth, and in their using the hind-legs in kicking as the principal means of defense, like the Horse, (and not merely as the occasional, like many Ruminants,) they diverge from the other Cornigers and rightly constitute a separate family, and one *hypotypic* in grade. It is stated that the males sometimes make use of their horns in attack; and one female at the Zoological Gardens, London, is said to have driven her horns through an

inch board. As the head of a Camelopard is raised seventeen or eighteen feet above the ground, the systemic force in this inferior Herbivore is diffused through a sphere whose radius is nearly twice that of the Lion, and six to eight times that of its superior among Herbivores, a common Stag or Goat—a condition betokening very low grade. Its inferiority among Cornigers is also apparent in the small head and brains for so large a body, its singularly awkward use of its long limbs when running, and its being a *mute* animal.

(2.) The *Nudifronts.*—The Nudifronts manifest their inferiority to the preceding in different ways.—

(*a.*) In a comparatively relaxed condition of the extremities.

In the *Camelids*, the toes spread forward so that the animal walks on a pad or pads beneath the foot and toes; the hoofs are small, of symmetrical shape instead of being fitted to one another, and cover only the extremities of the toes; the scaphoid and cuboid bones of the tarsus are disjunct; and the cannon-bone, though single, is divided at its lower extremity to a higher point than in the Cornigers.

In the *Moschids*, the toes are lax, as in the Camelids, and similarly covered with short hoofs, so that there is not the appearance of a single cloven hoof; moreover the two posterior toes are elongated so as to touch the ground in walking; and, in one species, not only are the scaphoid and cuboid bones disjunct, but also the metacarpals and metatarsals which make up the cannon-bone of the Cornigers and Solipeds. In others, also, the metacarpals are not completely coalesced.

The *Anoplotherids* are like the Moschids in the lax condition of the two large toes; and, as in the *Moschus aquaticus*, the scaphoid and cuboid bones are disjunct and also the metacarpals and the metatarsals.

(*b.*) In the forehead not being a power-organ, and not furnished with horns.—

This condition in an animal may be a mark either of a highly cephalized, or of an enfeebled, life-system. In the Horse it appears to be the former. But in the Nudifronts, it is so associated with other proofs of inferiority that it is unquestionably additional evidence of this inferiority. Absence of horns characterizes the *females* of many Cornigers, which shows that it might naturally be a feature of related inferior species.

The Camel and Musk-deer have feeble heads, both as respects mechanical and psychical power. The Musk-deer not only has no trace of horns but the forehead is not used in defense or attack, being apparently unfitted for this purpose.

(*c.*) In their feeble means of defence and bizarre shapes.—

The Camel sometimes bites—an almost universal propensity among animals, there being a consciousness of power in the

jaws when none elsewhere. The male Musk-deer is aided by long canines; yet it is a very timid animal, and although it takes extraordinary bounds when fleeing from a pursuer, it is said to become very soon exhausted, and thus is a little after the Grasshopper-style among hypotypic Insects. The Llamas spit.

The Camel has a body out of proportion to its legs, and exhibits awkwardness in features and gait; its hump is an abnormal growth of fatty and cellular tissue, having no functional value beyond that of serving as fuel for the craft when out on the desert; and its formation evinces large vegetative powers with consequently feeble systemic control.

(*d.*) In the presence of canines in most of the species; and in the Anoplotherids the set of teeth, besides being complete, having the canines short and not projecting, as in Man.—

The variation from the Ruminant type in the teeth shows a tendency to return to normal regularity and simplicity, as is common in *inferior* species (Art. I, pp. 326, 440), and is not a mark of elevation toward the Pachyderms.

Owen observes that an Anoplotherid resembles, in its absence of horns, its divided metatarsals and metacarpals, its lax toes, and its even and normal number of teeth, "the embryo Ruminant," these characteristics of the embryo being retained in them through adult life. He speaks of it, again, as exhibiting the features of the more generalized (or less specialized) Mammalian type, and remarks upon the same as also shown, though less strikingly, in the Camel. This relation, so correctly presented, accords with the view we hold, that these species are low in grade of cephalization; for a condition analogous to that of an animal in an unfinished or young state is one of comparative feebleness. The embryological resemblance, on this view, extends not only to *form* but also to *force*.

The *Pachydermatoid* qualities in the Moschids, and some among those so regarded in the Camelids, correspond therefore to a *degradation* of the Ruminant-type.

On page 165, the long-amplificate jaws and limbs of Solipeds and typical Ruminants are shown to be mutually dependent on that condition of the systemic force which is essential in order to bring out the Ruminant type-structure. It here appears that the *relaxed* or enfeebled condition of that force which leads to a lax state of the digits or extremities of the limbs is attended by modifications of the teeth—the dental series losing its type-character by the development of some or all of the missing teeth, and so returning toward elemental regularity. The two extremes of the body, the jaws and the limbs, thus vary together with the enfeebling or relaxation of the systemic force.

It is apparent, from this survey, that the Nudifronts are distinct from the higher Sthenomeres in several important characteristics,

indicative, each, of inferiority of grade. They are feeble in the head, and have no use for the forehead in attack or defense; they are weak as to means of defense of any kind; they have a lax condition of the extremities; they have a more complete and regular series of teeth, but as a result of a more diffused state of the systemic force, or less systemic control.

C. *Sirenians.*

The distinctions of the Sirenians have already been sufficiently indicated (p. 169).

In conclusion, the writer may here state that he does not look upon the classification which has been presented, as in all points that to which *beyond question* the right application of the principle of cephalization leads; but only as that which, as far as he now understands the facts and the principle, appears to him to be correct to nature.

D. *Dynamical considerations.*

1. *Amplification.*—On page 165 it is shown that in the skeleton of the long-amplificate Herbivores, the head and limbs are both elongated, although unequally; and that the elongation is little or none in the basal portion of these parts, while large in the rest, and especially toward the extremities of both the jaws and limbs.

On page 174, it is likewise shown that a relaxation of the parts in the extremities of the limbs is concurrent with a relaxing also of the elements of the jaws.

Thus the head and the limbs, parts alike circumferential, undergo analogous changes under similar conditions—the amplification in the *head* increasing from the basal portion of the skull toward the extremity of the jaws; and that in the *limbs* increasing from the body toward the extremities of these limbs.

Now it is to be noted that, while the head and the limbs diminish in amplification toward their basal portions, they are separated in the same species by a *long-amplificate neck.* It seems to follow, therefore, that the head is one centre of amplification, and the body another; or, in other words, that there are two distinct centres of amplification, a *cephalic* and a *thoracic*, the former the *primary.*

The question may be asked, whether the neck, in its amplification, should be considered as subordinate to the cephalic, or to the thoracic, centre, or to both equally. In reply, it is to be observed that the amplification in the case of the neck accords in amount much more nearly with that in the limbs than with that in the head. Moreover, short limbs and a short neck go together (as in the natatorial Herbivores and Mutilates), even

when the head is excessively elongated; and when the limbs are reduced to fins, as in Fishes, the neck is essentially wanting. Again, the longer cervical vertebræ are those most remote from the body, and the stoutest those nearest it; and, in the Camelopard, an animal in which the part of the limbs remote from the body is very much elongated, these cervical vertebræ remote from the body are likewise much elongated. It would hence appear that the amplification in the neck in these species is subordinate mainly to the thoracic or secondary centre.

But although this argument in favor of a connection at times between amplification in the neck and limbs may appear direct, we deem it only a doubtful suggestion. In any case, the fact of two systemic centres in Mammals seems to be established—one, the *cephalic* or *superior*, quite small in radius and with narrow limits of amplification; the other, the *thoracic* or *inferior*, very large in radius, and admitting of a wide range of amplification.

In Crustaceans the head and thorax make one single division of the body, the cephalothorax; and the cephalic nervous mass is often quite near the first thoracic, the two in some inferior species being on opposite sides of the esophagus. The cephalothorax here corresponds, therefore, to one single primary centre; and this centre is situated near the anterior margin of the mouth-aperture, or between the mandibular and 2nd-antennary segments, where it is placed by the writer in his former articles on this subject. There is an inferior or *secondary* centre in Crustaceans, but this is abdominal, as remarked in Art. I, p. 322. In Insects, as the body consists of three parts, a head, thorax and abdomen, there appear to be, besides the cephalic, two secondary centres, a thoracic and an abdominal; and in the Mantids and like species we have an example of a large anterior amplification of the thoracic. At page 328 of Art. I, a fact is mentioned bearing on the existence of two centres in Worms.

While amplification, then, depends on the degree of systemic control over vegetative growth and development, it may take place about the structure as a systemic unit, or about its primary and secondary systemic centres; and each centre may be more or less independent of the others in the amplification subordinate to it.

When, in an organism, the systemic force controls in the highest possible degree, under the type, the tendency to vegetative increase, or the mere powers of growth (the centrifugal tendency), there is the highest concentration and greatest circumferential contraction; and when in any less degree, there is amplification or circumferential extension.

When the systemic control is still so great as to keep the parts essentially within typical proportions as to relative lengths of parts, the amplification, if any, is simply gross-amplification—gross-amplification of the whole bony structure in superior spe-

cies, and of fatty, cellular and dermal tissues mainly, in species of a feebler life-system. But when the control is less complete, the parts of the bony structure increase *in length* by amplification, especially the more circumferential portions of them—*this amplificating tendency increasing in amount with the distance from the systemic centre or centres*—and the structure is long-amplificate. With a feebler life-system, not able to keep the structure evolved to type-perfection, the limbs may have lax or imperfect extremities, that is, lax as compared with their condition in the typical species under the type.[a]

2. *Definiteness of the distinction of gross-amplificate and long-amplificate.*—It has been observed that the two higher groups of terrestrial Herbivores are distinguished, the first, by being very generally gross-amplificate in the structures included, and the second by being long-amplificate, and that the two groups are thus quite well separated, there being but few cases of long-amplification in the former, and the gross-amplification in the latter taking place upon long-amplificate structures. It is a general fact throughout the animal kingdom that the long-amplificate groups under a type stand apart from, instead of blending insensibly in this respect with, the typical or gross-amplificate groups. Thus there is a Tipulid group among Dipters; a Grallatorial group among Birds of the tribe of Præcoces; a Heron group among the Altrices; a Serpentarius family among the Accipiters, etc.

The reason for this definiteness of limit between gross-amplificate or typical forms and long-amplificate is apparent from the preceding discussion. To produce the former, there is the systemic control which determines typical proportions and admits only of narrow limits of variation. For the latter, there is a diminished degree of that control, leaving vegetative growth to elongate the structure; and this diminution is not one of gradual stages, but an abrupt step down to the new condition. The limits of typical proportions once fairly overstepped, the structures pass suddenly to amplificate forms of very varied proportions. This capability of elongating the bony skeleton in Sthenomeres is very different from that of mere general enlargement which characterizes the Sthenorhines; and without an abruptness of transition between the two conditions the two types would not stand as far apart as they do in style of amplification.

3. *Axial distribution of force.—The retroferent method of decephalization.*—There is another law with regard to the systemic force, to which the above, relating to amplification, is actually subordi-

[a] The separateness of these two powers is also illustrated by the arrest of development in the brain, in many cases, as shown by fewer gyri and a greater simplicity of folds, while there is an increase of size up to normal dimensions. See W. O. Minor's translation of articles by Dr. Wagner, in this Journal [2], xxxiv, 188, and, in particular, the remark of Dr. Minor on this point, on p. 199.

nate—which is, that *the force may vary in cephalic concentration, and thereby in its distribution along the principal body-axis.*

It has been shown in this and the former articles that there is often, with descending grade of species, a transfer of force and function backward in the structure—a method of decephalization termed the *retroferent*, and including under it, the *prosthenic*, *metasthenic* and *urosthenic* conditions of structure. These have been illustrated from all departments of the animal kingdom; and with examples from Herbivores in the preceding pages. We refer again to the facts among Crustaceans in this Journal (vol. xxii, 14, 1856, and the chapter in the author's Expl. Exped. Report, p. 1412,) as especially clear and conclusive, and as having peculiar interest because historically the source in the writer's mind of the principles here explained.

Moreover, this backward transfer of force and function manifests itself also in the posterior elongation of the structure and also in some anterior dilation. Conversely, elevation of grade is manifested in the abbreviation of the structure behind, and to some extent also anteriorly, and in the transfer of force and function forward, or toward the cephalic extremity.

This connection of grade with a transfer of force along the body-axis—through a weakening or strengthening of the cephalic concentration—is dependent on the polar or cephalic nature of an animal—a condition remarked upon in Art I, at page 321, and referred to at p. 157 of this paper. The higher the grade of a species under a type, the greater the extent to which the force of the system is gathered in, or toward, the cephalic extremity or pole; and the lower the grade, the more complete its diffusion toward the posterior extremity.[*]

In the forward transfer attending cephalic concentration, the anterior limbs, as the species rise in prosthenic character, increase in muscular force, so that, as in Carnivores, this force is far greater in the fore-limbs than in the hind-limbs. When the transfer of force toward and about the anterior or cephalic extremity is at its maximum under any type, the structure is *prosthenic* in the highest degree possible for that type. But if the anterior extremity of the body-axis is not in this maximum state, owing to a diffusion of the force posteriorly, the condition is one less prosthenic; by a further loss and diffusion posteriorly, there may be another step down (for such transitions, as we have before found, appear to be by a *saltus*) perhaps to a lower grade of prosthenic, or else, still lower, to a *metasthenic* condition, and attending this, there is often an increasing length of body; by a further loss or diffusion posteriorly, there may be the pro-

[*] In my last article (Art. II, p. 10) I have referred the amplificate and retroferent methods of decephalization alike to *apocentric* distribution of force—or diffusion away from the principal or cephalic systemic centre. This, although true, is but an imperfect expression of the fact.

founder descent to a *urosthenic* condition, with great length behind and a large part of the force of the structure thrown into the caudal extremity.

But, besides the increase of muscular force attending cephalic concentration, there is also increase of cephalic force—the sensorial and higher cephalic—an increase which is not so easily measured or compared. Man is probably prosthenic looking only to his limbs, the arms being stronger than the legs. Yet this is but a small fraction of the force which makes him the prosthenic being he is. The force is so largely purely cephalic, that he may be styled, with special appropriateness, *cephalosthenic.* In such a species the increase of force along the body-axis from behind forward would be represented by a very rapid divergence of lines; in a Carnivore, by a divergence much less rapid; in a Whale by lines diverging but little from parallelism.

When the supremacy of the cephalic extremity in an organism is of high order, the cephalic centre is near the front margin of the head. Thus in Man, the being eminently of onward head-power, the jaws project but slightly beyond the anterior margin of the brain; moreover this cephalic concentration and contraction is connected with a reduction of the number of teeth from 44 to 32, one pair of incisors and two of premolars being wanting in either jaw out of the full number that belongs to the Mammal type. There is a great contrast between this abbreviated form of head and the elongated cranium of the 44-toothed Anoplothere, one of the lowest of Herbivores.

When the cephalic supremacy is so feeble that the force approximates to equality along all parts of the body-axis, the animal is the next thing in grade of life to a plant; the cephalic centre in such a case often has a position remote from the anterior extremity, the head portion becoming greatly dilated, as in the Whale as mentioned on page 160. If, in addition, the systemic force is feeble, the body may be contracted both before and behind, about the *nearly central* cephalic pole, as in Radiates.

With decreasing cephalic concentration, there may be not only increasing length throughout the structure, and especially circumferentially, but also an increasing relaxation of the parts of the structure, and a tendency toward a resolution into its normal elements, or an elementalizing of it; and also a tendency toward an equality in the series of parts or elements. This is decephalization by the *analytic* method explained in Art. I, p. 326.

The same kind of relaxation, favors not only ordinary vegetative increase, and an analytic resolution of structure, but often, also, that extraordinary multiplication of parts included under the *multiplicative* method of decephalization (Art. I, p. 325), and that multiplication of ova or young at a birth, included under the *genetic* method (Art. I, p. 330). In the higher animal species,

the forces and material of the being can develop at one time but one or a few ova; in others inferior, the amount required for each is so small, or, is so small a part of the whole energies of the individual, that the number produced is almost indefinitely large.

4. *Relation of the law of amplification to the law of axial distribution of force.*—The condition as to the distribution of force along the body-axis under a type, determines, as has been shown, the form or general nature of the structure, in any case, and the structure thus established is that which undergoes amplification. Thus the law of amplification is secondary to the law of axial distribution. Gross-amplification in a Whale is amplification of a *urosthenic* structure, or one in which the forces are so distributed along the axis that the anterior pole is not very highly superior to the posterior—a structure which is of great length and size behind *because* urosthenic, or feeble in cephalic polarity, while, at the same time, powerful in life-system.

5. *Diminution of cephalic concentration or polarity not necessarily a diminution of the total amount of force in an organism.*—As a Whale has more locomotive force than any other animal, it is evident that the transfer of force posteriorly, or the loss of cephalic concentration, does not necessarily involve a great diminution of strength of body: in a transfer of force, there is not necessarily a lessening of force. In fact, it might be inferred from the case of the Whale, and also from examples among the higher Mammals, that sensorial and other higher cephalic force becomes converted, in the transfer posteriorly, into muscular force; so that a Whale is a representative of the force of a typical megasthene,—a Lion, for example—in the condition almost exclusively of *muscular* force. The last part of this statement may be quite true; for the Whale may not differ from a Lion so much in amount of systemic force as in the proportions of that force divided between the several kinds of muscular, sensorial, and psychical. But this commutation of kinds of force cannot properly be admitted. It is more correct to say that the systemic developments in one case produce almost solely muscular force; in the other, less of this with a larger proportion of sensorial, or sensorial and psychical; and that these proportions are determined by the cephalic polarity of the life-energy characterizing the organism under development. The brain is the last part of an animal that is perfected. It becomes complete in its powers only after the rest of the structure has so far reached its limits of growth that the whole system may combine its nutrient energies and material on the one great feature of the being. In this way the cephalized structure attains its most highly cephalized condition.

The views here set forth rest on the ground that in a living organism there are not only molecular forces everywhere individually at work, carrying on all changes and growth, but also

that there is centralized control over all molecular forces, determining the limits, nature and condition of the organism.[10]

I would not be understood as including Man's higher nature among the attributes that can be developed out of simple matter and cephalized life. For Man evinces in his power to comprehend Nature's laws and use them for his physical, intellectual and moral progress, that he is *above* Nature. He shows in his thoughts of the infinite—in his recognition of an omnipotent Creator, (or, as well, in his efforts to reason himself out of this recognition, or into the substitution of an infinite Nature)—in his sense of obligation to moral law, and law as emanating from an infinite God—in his aspirations towards the infinite—in his hopes reaching into the indefinite future—and in his capability of indefinite development, that he has within him an element of the infinite, a spiritual element, which places him above nature, constitutes his likeness to his Creator, and assures him of a future of spiritual existence apart from matter and its inferior developments.

6. *Distinction of Megasthenes and Microsthenes.*—The fact stated with regard to the powerful life-system of the Whale affords aid towards a definite understanding of the distinction between the great groups of Megasthenes and Microsthenes. The subdivisions of these groups are mentioned in a note to page 159, and in a manner to exhibit their parallelism:—the Quadrumanes and Chiropters being in one line, since they have long been regarded as correlates in many of their characters; so Carnivores and Insectivores in the second; Herbivores and Rodents in the third; and Mutilates and Edentates in the fourth. Carnivores and Insectivores are both carnivorous and both prosthenic tribes. Herbivores and Rodents are both herbivorous, and the larger and most characteristic part of the former and all of the latter are metasthenic. Mutilates and Edentates are both degradational types; the latter, like the former, sometimes multiplicate and elementalized in their teeth, sometimes wholly elliptical as to teeth, sometimes vast in amplification; and bearing, through all their structure, evidence of great inferiority among the placental Mammals. The mean sizes of the Megasthenes and Microsthenes have been shown to be about as 1 : 4.

Now the Whales, by their enormous muscular power, make it manifest, as has been explained, that they are true Megasthenes, or that the life-system is really large, not very much smaller perhaps than that of the higher Herbivores. Although degradational species, they still retain this peculiar feature of the Megasthenic type.

[10] This idea is illustrated by reference to the nature of coral polyps in the writer's Report on Zoophytes, 4to, 1846.

The Edentates are also large beasts, and the first impulse, under the influence of the sense of sight, is to declare them likewise Megasthenes, because they are big enough to be so. But these animals, large and small, while degradational like the Mutilates, are in striking contrast with the latter as regards muscular force and all other powers. They are cephalically feeble, below other Mammals; and they are of extreme muscular debility as compared with a Whale or any Megasthene. There is no increase of muscular power *because* of the degradation of the sensorial and psychical elements, as in the Whale, but a general degradation of every function and part. Thus they are literally microsthenic in life-system. Compared even with a quick-moving Rodent, the slow Sloth is muscularly feeble; for relative strength is to be measured, not by the single blow that may be given, but by the product of the strength of a single blow into the number of times this blow may be repeated in a given time, as for instance, in twenty-four hours.

The Edentates appear therefore to be as truly degradational *Microsthenes*, as the Mutilates are degradational Megasthenes. They show their feebleness according to the elliptic method, in their head and jaws to an extent not manifested even among Mutilates.

The Edentate type exhibits its inferiority to that of all other placental Mammals also in admitting more or less of a commingling of Reptilian characteristics with the Mammalian, as appears in the scale-made or shield-like armor of many species, the feeble sensibility of all, and several peculiarities in the skeleton: —showing thus that the type holds a position in some respects between those of Mammals and Reptiles, or at the extreme lower end of the placental series.

D. *Additional Observations.*

1. *Grade among groups.*—The groups under the several subdivisions in the proposed classification show a gradation in rank corresponding with their position. Moreover, the third group, as in the higher subdivisions of the animal kingdom, and in those presented in the article on Insects, is literally a *hypotypic* group. The hypotypic features are connected either with a more or less aquatic mode of life, and gross-amplification, or with long-amplification.

It may be here observed that were we to make the Imparidigitates and Paridigitates the two grander divisions of Herbivores, and so unite the Solipeds to the Proboscideans and Tapirideans, and the Suideans to the Ruminants, the Solipeds would have to go, because *metasthenic*, at the foot of the higher division, when they have the characteristics of a *superior* typical group, and not those of a hypotypic; and the Suideans would

take their place at the head of the lower, before the Ruminants, because *prosthenic*, although decidedly hypotypic in shape, structure and stupidity.

2. *Designations of the grades of subdivisions in the tribe of Herbivores.*—Under the tribe of Herbivores, the subdivisions of the first grade, that is, those of Sthenorhines, Sthenomeres, and Sirenians, may be conveniently named *subtribes*. The subdivisions of the second grade, or those of Proboscideans, Tapirideans, etc., may be called *tribules*, this word being diminutive of *tribe*.

The subdivisions of the third grade are, with three exceptions, *families*. The three exceptions are that of the Tapiroids among Sthenorhines, and those of Cornigers and Nudifronts among Sthenomeres, for each of which the term *stirps*, one already somewhat in use in classification, might be employed. The name of the group of *Rhinocerotids* might be written Rhinocerotoids, so as to make it coördinate with that of Tapiroids; but it would still contain only the single family of *Rhinocerotids*, and the change would be adding words to the system without sufficient reason.

3. *Geological History.*—The earliest of Herbivores in geological history, or those of the opening Tertiary period, were mostly species of Tapiroids and Nudifronts—*Lophiodon* (Tapirid) of the earliest Eocene, being one of the genera of the former, and *Dichobune* (Anoplotherid) of the same epoch, of the latter. The Lophiodonts led off, therefore, the Sthenorhines, and the Dichobunes, the Sthenomeres. Later in the Eocene, if not cotemporaneously, there existed the Paleotheres and the true Anoplotheres, as other representatives, respectively, of these two grand divisions; and with these there were species of Suideans of the Chœropotamid type. The Sirenians were also among the first of Herbivores; and the earliest Eocene genus of these *urosthenic* species, Halitherium, was related to the Halicorids.

It is to these Eocene species, according to all analogy, that we should look for the closest approximation of the two grand divisions of terrestrial Herbivores. And so in actual fact, the Anoplotherids, as long since observed by Cuvier, have near relations in structure to the Tapirids and Suids among the Sthenorhines, as well as to the Camelids among Sthenomeres. This accords in general relation with the facts among Insects mentioned at page 33 in Art. II.

In the Paleotheres, among the earliest of Sthenorhines, moreover, there was, besides an approximation to the Sthenomeres in general structure, an approximation also in long-amplification (p. 168), a feature which is typical for the Sthenomeres, but which disappeared almost entirely from among the Sthenorhines in the later exhibitions of the type.

ART. XIV.—*Note on the position of Amphibians among the classes of Vertebrates;* by JAMES D. DANA.

IN a recent article by the writer on the *Parallel relations of the classes of Vertebrates*,[1] Amphibians are made the inferior division of the class of Reptiles. The usual arguments against this view were not alluded to because they were believed to be familiar to all interested in the subject, and their discussion at the time seemed not to be required. A few words with regard to them are here added in order to set forth more distinctly the special value of the analogies appealed to in that paper.

The evidence in favor of separating the Amphibians from Reptiles as an independent *class* is undeniably of great weight. Their approximation to Fishes in embryological development and the corresponding divergence from ordinary Reptiles have the appearance of being decisive proof that they are as closely related to Fishes as to Reptiles, and, therefore, that they occupy an intermediate position between the two in classification.

The chemical researches on the composition of eggs by Fremy, made a few years since,[2] claiming to show among their results "the curious physiological fact that Amphibians, besides passing through an early condition of existence like that of Fishes, lay eggs which have the greatest affinity in chemical composition to those of Fishes," seemed to the writer, when they were first published, to carry the evidence to the most fundamental point in the nature of the species, even below that of embryological development. If the fundamental elements thus differ, should not the superstructures also, and far more widely?

But the question recurred whether in the subdivision of the subkingdoms of animal life into classes, it is not, after all, the more correct method to take note primarily of species in their finished or adult state; that is, whether adults do not express the true idea and nature of species, or the objects to be classified, rather than the special series of changes through which the adult characteristics are reached.

In favor of an affirmative reply to this question, the fact stands out prominently that, as regards the subkingdoms in animal life, embryology in the hands of the best embryologists has only sustained what Cuvier had derived from the study of the adult animals themselves; and in the hands of other embryological investigators, and some of the latest, even these great natural groups have not been left without mutilation. And as to the subordinate divisions under the subkingdoms there is not only great diversity in the different embryological systems, but violations of natural affinities in all. Professor Agassiz, in his Essay

[1] This Journal, [2], xxxvi, 315, November, 1863.
[2] *This Journal*, [2], xix, 38, 238, xx, 65, 1855, from the *Journ. de Pharmacie*, 1854.

on Classification,[1] criticizes the systems of Van Beneden, Kölliker and Vogt, on account of their violating the structural affinities of groups, implying that embryological conclusions have to be tested by a reference to the natural types of structure. In nature a specific type is often expressed in a long series of species running through a very wide range of grade; and structures so diverse in grade as those of the higher and lower extreme groups are diverse in the nature of the changes which take place in the course of embryological development. Not appreciating this fact, embryological systemists have cut the series, and made bold demarcations between parts that are essentially one in type. Thus has resulted the separation of the class of Worms from Articulates by both Van Beneden and Vogt, and of the order of Cephalopods from Mollusks by the latter, etc.; and such errors will continue to attend upon the decisions of pure embryology until the precise value of its characteristics in classification is understood.

If, then, the structural relations of the developed animals are an authority to which embryology must appeal, the adult Amphibians may claim to be considered, on a question of their relations to ordinary Reptiles, even before their eggs and young. Embryology proves that Amphibians and ordinary Reptiles are *distinct groups*, as is proved also by structural considerations; but, in the present state of the science, it can hardly be said to demonstrate that these groups are *classes*; coördinate with those of Birds and Mammals;—and I venture to say, as regards the separation of groups, that, in no state, will it prove what the adult structures will not sustain.

But, further, if it were proposed to make a Reptilian whose early life should be aquatic, could it be accomplished by means of eggs having the same chemical constitution as those of ordinary or terrestrial Reptiles? The development, at each step, involves, and depends upon, chemical changes; and it is hence

[1] See the first volume of his Contributions to the Natural History of the United States (pages 220 to 232). Even von Baer, as here quoted, in subdividing the placental Mammals, places in one group the *Carnivores, Insectivores* and *Rodents*, and in another *Man, Monkeys, Ruminants, Pachyderms* and *Cetaceans*. Van Beneden divides the Invertebrates into two groups, the *first*, including Insects, Myriapods, Spiders and Crustaceans, the *second*, the subkingdom of Mollusks, *the inferior part of the subkingdom of Articulates*, that is, *Worms*, together with the Radiates, Rhizopods and Infusoria; and his division of Polyps, among the Radiates, in his latest amendments of his system, *includes both Polyps and Acalephs*. Vogt makes three grand groups of animals: the *first*, including Vertebrates, and all Articulates *excepting Worms*; the *second*, Mollusks, Worms and Radiates; the *third*, Infusoria, and Rhizopods; and his division of Mollusks *does not embrace the Cephalopods*, while it does include a tribe of Acalephs. Recently, Prof. Huxley, in lectures before the Royal College of Surgeons, of which a report is given in the Medical Times and Gazette, for May, 1863, says, (page 555,) after discussing the importance of the placenta in Mammals as a basis of classification, that, in his view, there is no difficulty in the way of a classification which unites the Proboscideans with the Rodents rather than with Paridigitate and Imparidigitate Herbivores.

reasonable to infer that the egg which was to be developed when bathed in *water* should thus differ somewhat from one that was to be developed in the *air;* and also that such *aquatic* eggs should approach in constitution those of the true *aquatic* Vertebrates, or Fishes. We may safely conclude, further, that the method of development for eggs thus different in constitution, and at the same time of inferior grade, would necessarily differ from those of ordinary Reptiles, and differ by approximating to those of Fishes. Accordingly, in Amphibians there may be only that divergence from the method of making a Reptile that was required in order that a division of inferior Reptiles should exist characterized by a fish-like life in the young state.

The fact is that the *superstructures* (p. 184) do *not* widely differ. In the adult state the species are Reptiles in all essential structural characters:—they are air-breathing; they have imperfect circulation and, consequently, are cold-blooded; and outside or inside there are no fundamental differences in type that would require a separation from the Reptilian class. The divergence is small compared with that between typical Amphibians and Fishes.

Such considerations are sufficient to authorize the assertion that the evidence in favor of regarding Amphibians as Reptiles at least balances that on the other side, if it does not outweigh it.

Now add to the above the analogy drawn from other classes of Vertebrates, as presented in the paper referred to in the opening paragraph of this article:—that the class of Mammals has its *inferior* subdivision—the Oötocoids, or *semioviparous* species—intermediate between ordinary Mammals and the *oviparous* classes below; that the class of Birds, according to recent discoveries, has its *inferior* subdivision—the Erpetoids, or *Reptilian* species—between ordinary Birds and *Reptiles;* and that between ordinary Reptiles and the class below, or that of *Fishes*, there are the Amphibians, or *fish-like* Reptiles; also, that the grand distinction between semioviparous and ordinary Mammals is manifested in *their embryological development*, or their young state, as well as that between Amphibians and ordinary Reptiles; and the evidence becomes strong that if Oötocoids constitute a hypotypic subdivision of Mammals, so Amphibians constitute a hypotypic subdivision of Reptiles. It is not necessary to repeat at length the argument on this point, as the reader can easily refer to the former paper on the subject. This point is illustrated also in the following article in the same volume (Article I, On the Classification of animals based on the principle of Cephalization) by a wider range of analogies, showing that similar hypotypic groups constitute the lower subdivision in several departments of the animal kingdom.

ART. XV.—*On Celestial Dynamics;*[1] by DR. J. R. MAYER.

THE movements of celestial bodies in an absolute vacuum would be as uniform as those of a mathematical pendulum, whereas a resisting medium pervading all space would cause the planets to move in shorter and shorter orbits, and at last to fall into the sun.

Assuming such a resisting medium, these wandering celestial bodies must have on the periphery of the solar system their cradle, and in its centre their grave; and however long the duration, and however great the number of their revolutions may be, as many masses will on the average in a certain time arrive at the sun as formerly in a like period of time came within his sphere of attraction.

All these bodies plunge with a violent impetus into their common grave. Since no cause exists without an effect; each of these cosmical masses will, like a weight falling to the earth, produce by its percussion an amount of heat proportional to its *vis viva.*

From the idea of a sun whose attraction acts throughout space, of ponderable bodies scattered throughout the universe, and of a resisting ether, another idea necessarily follows—that, namely, of a continual and inexhaustible generation of heat on the central body of this cosmical system.

Whether such a conception be realized in our solar system—whether in other words the wonderful and permanent evolution of light and heat be caused by the uninterrupted fall of cosmical matter into the sun—will now be more closely examined.

The existence of matter in a primordial condition (*Urmaterie*), moving about in the universe, and assumed to follow the attraction of the nearest stellar system, will scarcely be denied by astronomers and physicists; for the richness of surrounding nature, as well as the aspect of the starry heavens prevents the belief that the wide space which separates our solar system from the regions governed by the other fixed stars is a vacant solitude destitute of matter. We shall leave, however, all suppositions concerning subjects so distant from us both in time and space, and confine our attention exclusively to what may be learned from the observation of the existing state of things.

Besides the fourteen known planets with their eighteen satellites, a great many other cosmical masses move within the space of the planetary system of which the comets deserve to be mentioned first.

Kepler's celebrated statement that "there are more comets in

[1] Continued from vol. xxxvi, p. 266.

the heavens than fish in the ocean," is founded on the fact that, of all the comets belonging to our solar system, comparatively few can be seen by the inhabitants of the earth, and therefore the not inconsiderable number of actually observed comets obliges us, according to the rules of the calculus of probabilities, to assume the existence of a great many more beyond the sphere of our vision.

Besides planets, satellites, and comets, another class of celestial bodies exists within our solar system. These are masses which, on account of their smallness, may be considered as cosmical atoms, and which Arago has appropriately called asteroids. They, like the planets and the comets, are governed by gravity, and move in elliptical orbits round the sun. When accident brings them into the immediate neighborhood of the earth, they produce the phenomena of shooting stars and fireballs.

It has been shown, by repeated observation, that on a bright night twenty minutes seldom elapse without a shooting-star being visible to an observer in any situation. At certain times these meteors are observed in astonishingly great numbers; during the meteoric shower at Boston, which lasted nine hours, when they were said to fall, "crowded together like snowflakes," they were estimated as at least 240,000. On the whole, the number of asteroids which come near the earth in the space of a year must be computed to be many thousands of millions.[1] This, without doubt, is only a small fraction of the number of asteroids that move round the sun, which number, according to the rules of the calculus of probabilities, approaches infinity.

As has been already stated, on the existence of a resisting ether it depends whether the celestial bodies, the planets, the comets, and the asteroids move at constant mean distances around the sun, or whether they are constantly approaching that central body.

Scientific men do not doubt the existence of such an ether. Littrow, amongst others, expresses himself on this point as follows:—"The assumption that the planets and comets move in an absolute vacuum can in no way be admitted. Even if the space between celestial bodies contained no other matter than that necessary for the existence of light (whether light be considered as emission of matter or the undulations of a universal ether), this alone is sufficient to alter the motion of the planets in the course of time and the arrangement of the whole system itself; the fall of all the planets and the comets into the sun and the destruction of the present state of the solar system must be the final result of this action."

[1] Compare Prof. Newton's computation of the approximate number of meteors in the August ring alone, which makes it more than 300,000,000,000,000: this Journal, xxxii, 451.—Eds.

A direct proof of the existence of such a resisting medium has been furnished by the academician Encke. He found that the comet named after him, which revolves round the sun in the short space of 1207 days, shows a regular acceleration of its motion, in consequence of which the time of each revolution is shortened by about six hours.

From the great density and magnitude of the planets, the shortening of the diameters of their orbits proceeds, as might be expected, very slowly, and is up to the present time inappreciable. The smaller the cosmical masses are, on the contrary, other circumstances remaining the same, the faster they move towards the sun: it may therefore happen that in a space of time wherein the mean distance of the earth from the sun would diminish one metre, a small asteroid would travel more than one thousand miles towards the central body.

As cosmical masses stream from all sides in immense numbers towards the sun, it follows that they must become more and more crowded together as they approach thereto. The conjecture at once suggests itself that the zodiacal light, the nebulous light of vast dimensions which surrounds the sun, owes its origin to such closely packed asteroids. However it may be, this much is certain, this phenomenon is caused by matter which moves according to the same laws as the planets round the sun, and it consequently follows that the whole mass which originates the zodiacal light is continually approaching the sun and falling into it.

This light does not surround the sun uniformly on all sides; that is to say, it has not the form of a sphere, but that of a thin convex lens, the greater diameter of which is in the plane of the solar equator, and accordingly it has to an observer on our globe a pyramidal form. Such lenticular distribution of the masses in the universe is repeated in a remarkable manner in the disposition of the planets and the fixed stars.

From the great number of cometary masses and asteroids and the zodiacal light on the one hand, and the existence of a resisting ether on the other, it necessarily follows that ponderable matter must continually be arriving on the solar surface. The effect produced by these masses evidently depends on their final velocity; and, in order to determine the latter, we shall discuss some of the elements of the theory of gravitation.

The final velocity of a weight attracted by, and moving toward, a celestial body will become greater as the height through which the weight falls increases. This velocity, however, if it be only produced by the fall, cannot exceed a certain magnitude; it has a maximum, the value of which depends on the volume and mass of the attracting celestial body.

Let r be the radius of a spherical and solid celestial body, and g the velocity at the end of the first second of a weight falling on the surface of this body; then the greatest velocity which this weight can obtain by its fall toward the celestial body, or the velocity with which it will arrive at its surface after a fall from an infinite height, is $\sqrt{2gr}$ in one second. This number, wherein g and r are expressed in metres, we shall call G.

For our globe the value of g is 9·8164 .... and that of r 6,369,800; and consequently on our earth

$$G=\sqrt{(2\times 9{\cdot}8164\times 6{,}369{,}800)}=11{,}183.$$

The solar radius is 112·05 times that of the earth and the velocity produced by gravity on the sun's surface is 28·36 times greater than the same velocity on the surface of our globe; the greatest velocity therefore which a body could obtain in consequence of the solar attraction, or

$$G=\sqrt{(28{\cdot}36\times 112{\cdot}05)}\times 11{,}183=630{,}400;$$

that is, this maximum velocity is equal to 630,400 metres, or 85 geographical miles in one second.

By the help of this constant number, which may be called the *characteristic* of the solar system, the velocity of a body in central motion may easily be determined at any point of its orbit. Let a be the mean distance of the planetary body from the centre of gravity of the sun, or the greater semidiameter of its orbit (the radius of the sun being taken as unity); and let h be the distance of the same body at any point of its orbit from the centre of gravity of the sun; then the velocity, expressed in metres, of the planet at the distance h is

$$G\times\sqrt{\frac{2a-h}{2a\times h}}.$$

At the moment the planet comes in contact with the solar surface, h is equal to 1, and its velocity is therefore

$$G\times\sqrt{\frac{2a-1}{2a}}.$$

It follows from this formula that the smaller $2a$ (or the major axis of the orbit of a planetary body) becomes, the less will be its velocity when it reaches the sun. This velocity, like the major axis, has a minimum; for so long as the planet moves outside the sun, its major axis cannot be shorter than the diameter of the sun, or, taking the solar radius as a unit, the quantity $2a$ can never be less than 2. The smallest velocity with which we can imagine a cosmical body to arrive on the surface of the sun is consequently

$$G\times\sqrt{\frac{1}{2}}=445{,}750,$$

or a velocity of 60 geographical miles in one second.

For this smallest value, the orbit of the asteroid is circular; for a larger value it becomes elliptical, until finally, with increasing eccentricity, when the value of $2a$ approaches infinity, the orbit becomes a parabola. In this last case the velocity is

$$G\times\sqrt{\frac{\infty-1}{\infty}}=G,$$

or 85 geographical miles in one second.

If the value of the major axis become nagative, or the orbit assume the form of a hyperbola, the velocity may increase without end. But this could only happen when cosmical masses enter the space of the solar system with a projected velocity, or when masses, having missed the sun's surface, move into the universe and never return; hence a velocity greater than G can only be regarded as a rare exception, and we shall therefore only consider velocities comprised within the limits of 60 and 80 miles.[2]

The final velocity with which a weight moving in a straight line toward the centre of the sun arrives at the solar surface is expressed by the formula

$$c=G\times\sqrt{\frac{h-1}{h}},$$

wherein c expresses the final velocities in metres, and h the original distance from the centre of the sun in terms of solar radius. If this formula be compared with the foregoing, it will be seen that a mass which, after moving in central motion, arrives at the sun's surface has the same velocity as it would possess had it fallen perpendicularly into the sun from a distance[3] equal to the major axis of its orbit; whence it is apparent that a planet, on arriving at the sun, moves at least as quickly as a weight which falls freely towards the sun from a distance as great as the solar radius, or 96,000 geographical miles.

What thermal effect corresponds to such velocities? Is the effect sufficiently great to play an important part in the immense development of heat on the sun?

This crucial question may be easily answered by the help of the preceding considerations. According to the formula given at the end of Chapter II, the degree of heat generated by percussion is

$$=0{\cdot}000139^\circ\times c^2,$$

where c denotes the velocity of the striking body expressed in metres. The velocity of an asteroid when it strikes the sun measures from 445,750 to 630,400 metres; the calorific effect of

[2] The relative velocity also with which an asteroid reaches the solar surface depends in some degree on the velocity of the sun's rotation. This, however, as well as the rotary effect of the asteroid, is without moment and may be neglected.

[3] This distance is to be counted from the centre of the sun.

the percussion is consequently equal to from 27½ to 55 millions of degrees of heat.[4]

An asteroid, therefore, by its fall into the sun developes from 4600 to 9200 times as much heat as would be generated by the combustion of an equal mass of coal.

V. *The Origin of the Sun's Heat* (*continuation*).

The question why the planets move in curved orbits, one of the grandest of problems, was solved by Newton in consequence, it is believed, of his reflecting on the fall of an apple. This story is not improbable, for we are on the right track for the discovery of truth when once we clearly recognize that between great and small no qualitative but only a quantitative difference exists—when we resist the suggestions of an ever active imagination, and look for the same laws in the greatest as well as in the smallest processes of nature.

This universal range is the essence of a law of nature, and the touchstone of the correctness of human theories. We observe the fall of an apple and investigate the law which governs this phenomenon; for the earth we substitute the sun, and for the apple a planet, and thus possess ourselves of the key to the mechanics of the heavens.

As the same laws prevail in the greater as well as in the smaller processes of nature, Newton's method may be used in solving the problem of the origin of the sun's heat. We know the connection between the space through which a body falls, the velocity, the *vis viva*, and the generation of heat on the surface of this globe; if we again substitute for the earth the sun, with a mass 350,000 greater, and for a height of a few metres celestial distances, we obtain a generation of heat exceeding all terrestrial measures. And since we have sufficient reason to assume the actual existence of such mechanical processes in the heavens, we find therein the only tenable explanation of the origin of the heat of the sun.

The fact that the development of heat by mechanical means on the surface of our globe is, as a rule, not so great, and cannot be so great as the generation of the same agent by chemical means, as by combustion, follows from the laws already discussed; and this fact cannot be used as an argument against the assumption of a greater development of heat by a greater expenditure of mechanical work. It has been shown that the heat generated by a weight falling from a height of 367 metres is only $\frac{1}{8000}$th part of the heat produced by the combustion of

[[4] Throughout this memoir the degrees of heat are expressed in the Centigrade scale. Unless stated to the contrary, the measures of length are given in geographical miles. A geographical mile $=\frac{1}{60}$ of degree of latitude $=1878$ metres, and an English mile $=1609$ metres.]

the same weight of coal; just as small as is the amount of heat developed by a weight moving with the not inconsiderable velocity of 85 metres in one second. But, according to the laws of mechanics, the effect is proportional to the square of velocity; if, therefore, the weight move 100 times faster, or with a velocity of 8500 metres in one second, it will produce a greater effect than the combustion of an equal quantity of coal.

It is true that so great a velocity cannot be obtained by human means; everyday experience, however, shows the development of high degrees of temperature by mechanical processes.

In the common flint and steel, the particles of steel which are struck off are sufficiently heated to burn in air. A few blows directed by a skillful blacksmith with a sledge-hammer against a piece of cold metal may raise the temperature of the metal at the points of collision to redness.

The new crank of a steamer, whilst being polished by friction, becomes red-hot, several buckets of water being required to cool it down to its ordinary temperature.

When a railroad train passes with even less than its ordinary velocity along a very sharp curve of the line, sparks are observed in consequence of the friction against the rails.

One of the grandest constructions for the production of motion by human art is the channel in which the wood was allowed to glide down from the steep and lofty sides of Mount Pilatus into the plain below. This wooden channel which was built about thirty years ago by the engineer Rupp, was 9 English miles in length; the largest trees were shot down it from the top to the bottom of the mountain in about two minutes and a half. The momentum possessed by the trees on their escaping at their journey's end from the channel was sufficiently great to bury their thicker ends in the ground to the depth of from 6 to 8 metres. To prevent the wood getting too hot and taking fire, water was conducted in many places into the channel.

This stupendous mechanical process, when compared with cosmical processes on the sun appears infinitely small. In the latter case it is the mass of the sun which attracts, and in place of the height of Mount Pilatus we have distances of a hundred thousand and more miles; the amount of heat generated by cosmical falls is therefore at least 9 million times greater than in our terrestrial example.

Rays of heat on passing through glass and other transparent bodies undergo partial absorption, which differs in degree, however, according to the temperature of the source from which the heat is derived. Heat radiated from sources less warm than boiling water is almost completely stopped by thin plates of glass. As the temperature of a source of heat increases, its

rays pass more copiously through diathermic bodies. A plate of glass, for example, weakens the rays of a red-hot substance, even when the latter is placed very close to it, much more than it does those emanating at a much greater distance from a white-hot body. If the quality of the sun's rays be examined in this respect, their diathermic energy is found to be far superior to that of all artificial sources of heat. The temperature of the focus of a concave metallic reflector in which the sun's light has been collected is only diminished from one-seventh to one-eighth by the interposition of a screen of glass. If the same experiment be made with an artificial and luminous source of heat, it is found that, though the focus be very hot when the screen is away, the interposition of the latter cuts off nearly all the heat; moreover, the focus will not recover its former temperature when reflector and screen are placed sufficiently near to the source of heat to make the focus appear brighter than it did in the former position without the glass screen.

The empirical law, that the diathermic energy of heat increases with the temperature of the source from which the heat is radiated, teaches us that the sun's surface must be much hotter than the most powerful process of combustion could render it.

Other methods furnish the same conclusion. If we imagine the sun to be surrounded by a hollow sphere, it is clear that the inner surface of this sphere must receive all the heat radiated from the sun. At the distance of our globe from the sun, such a sphere would have a radius of 215 times as great, and an area 46,000 times as large as the sun himself; those luminous and calorific rays, therefore, which meet this spherical surface at right angles retain only $\frac{1}{46,000}$th part of their original intensity.

If it be further considered that our atmosphere absorbs a part of the solar rays, it is clear that the rays which reach the tropics of our earth at noonday can only possess from $\frac{1}{50,000}$th to $\frac{1}{60,000}$th of the power with which they started. These rays when gathered from a surface of from 5 to 6 square metres, and concentrated in an area of one square centimetre, would produce about the temperature which exists on the sun, a temperature more than sufficient to vaporize platinum, rhodium, and similar metals.

The radiation calculated in Chap. III. likewise proves the enormous temperature of the solar surface. From the determination mentioned therein, it follows that each square centimetre of the sun's surface loses by radiation about 80 units of heat per minute—an immense quantity in comparison with terrestrial radiation.

A correct theory of the origin of the sun's heat must explain the cause of such enormous temperatures. This explanation can be deduced from the foregoing statement. According to Pouillet, the temperature at which bodies appear intensely white-hot is

about 1500° C. The heat generated by the combustion of one kilogram of hydrogen is, as determined by Dulong, 34,500, and according to the more recent experiments of Grassi, 34,666, units of heat. One part of hydrogen combines with eight parts of oxygen to form water; hence one kilogram of these two gases mixed in this ratio would produce 3850°.

Let us now compare this heat with the amount of the same agent generated by the fall of an asteroid into the sun. Without taking into account the low specific heat of such masses when compared with that of water, we find the heat developed by the asteroid to be from 7000 to 14,000 times greater than that of the oxyhydrogen mixture. From data like these, the extraordinary diathermic energy of the sun's rays, the immense radiation from his surface, and the high temperature in the focus of the reflector are easily accounted for.

The facts above mentioned show that, unless we assume on the sun the existence of matter with unheard of chemical properties as a *deus ex machinâ*, no chemical process could maintain the present high radiation of the sun; it also follows from the above results, that the chemical nature of bodies which fall into the sun does not in the least affect our conclusions; the effect produced by the most inflammable substance would not differ by one-thousandth part from that resulting from the fall of matter possessing but feeble chemical affinities. As the brightest artificial light appears dark in comparison with the sun's light, so the mechanical processes of the heavens throw into the shade the most powerful chemical actions.

The quality of the sun's rays, as dependent on his temperature, is of the greatest importance to mankind. If the solar heat were originated by a chemical process, and amounted near its source to a temperature of a few thousand degrees, it would be possible for the light to reach us, whilst the greater part of the more important calorific rays would be absorbed by the higher strata of our atmosphere and then returned to the universe.

In consequence of the high temperature of the sun, however, our atmosphere is highly diathermic to his rays, so that the latter reach the surface of our earth and warm it. The comparatively low temperature of the terrestrial surface is the cause why the heat cannot easily radiate back through the atmosphere into the universe. The atmosphere acts, therefore, like an envelope, which is easily pierced by the solar rays, but which offers considerable resistance to the radiant heat escaping from our earth; its action resembles that of a valve which allows a liquid to pass freely in one direction, but stops the flow in the opposite.

The action of the atmosphere is of the greatest importance as regards climate and meteorological processes. It must raise the mean temperature of the earth's surface. After the setting of

the sun—in fact, in all places where his rays do not reach the surface, the temperature of the earth would soon be as low as that of the universe, if the atmosphere were removed, or if it did not exist. Even the powerful solar rays in the tropics would be unable to preserve water in its liquid state.

Between the great cold which would reign at all times and in all places, and the moderate warmth which in reality exists on our globe, intermediate temperatures may be imagined; and it is easily seen that the mean temperature would decrease if the atmosphere were to become more and more rare. Such a rarefaction of a valve-like acting atmosphere actually takes place as we ascend higher and higher above the level of the sea, and it is accordingly and necessarily accompanied by a corresponding diminution of temperature.

This well-known fact of the lower mean temperature of places of greater altitude has led to the strangest hypotheses. The sun's rays were not supposed to contain all the conditions for warming a body, but to set in motion the "substance" of heat contained in the earth. This "substance" of heat, cold when at rest, was attracted by the earth, and was therefore found in greater abundance near the centre of the globe. This view, it was thought, explained why the warming power of the sun was so much weaker at the top of a mountain than at the bottom, and why, in spite of his immense radiation, he retained his full powers.

This belief, which especially prevails amongst imperfectly informed people, and which will scarcely succumb to correct views, is directly contradicted by the excellent experiments made by Pouillet at different altitudes with the pyrheliometer. These experiments show that, everything else being equal, the generation of heat by the solar rays is more powerful in higher altitudes than near the surface of our globe, and that consequently a portion of these rays is absorbed on their passage through the atmosphere. Why, in spite of this partial absorption, the mean temperature of low altitudes is nevertheless higher than it is in more elevated positions, is explained by the fact that the atmosphere stops to a far greater degree the calorific rays emanating from the earth than it does those from the sun.

VI. *The Constancy of the Sun's Mass.*

Newton, as is well known, considered light to be the emission of luminous particles from the sun. In the continued emission of light this great philosopher saw a cause tending to diminish the solar mass; and he assumed, in order to make good this loss, comets and other cosmical masses to be continually falling into the central body.

If we express this view of Newton's in the language of the undulatory theory, which is now universally accepted, we obtain the results developed in the preceding pages. It is true that our theory does not accept a peculiar "substance" of light or of heat; nevertheless, according to it, the radiation of light and heat consists also in purely material processes, in a sort of motion, in the vibrations of ponderable resisting substances. Quiescence is darkness and death; motion is light and life.

An undulating motion proceeding from a point or a plane and excited in an unlimited medium, cannot be imagined apart from another simultaneous motion, a translation of the particles themselves;[*] it therefore follows, not only from the emission, but also from the undulatory theory, that radiation continually diminishes the mass of the sun. Why, nevertheless, the mass of the sun does not really diminish has already been stated.

The radiation of the sun is a centrifugal action equivalent to a centripetal motion.

The calorific effect of the centrifugal action of the sun can be found by direct observation; it amounts, according to Chap. III, in one minute to 12,650 millions of cubic miles of heat, or 5·17 quadrillions of units of heat. In Chapter IV it has been shown that one kilogram of the mass of an asteroid originates from 27·5 to 55 millions of units of heat; the quantity of cosmical masses, therefore, which falls every minute into the sun amounts to from 94,000 to 188,000 billions of kilograms.

To obtain this remarkable result, we made use of a method which is common in physical inquiries. Observation of the moon's motion reveals to us the external form of the earth. The physicist determines with the torsion-balance the weight of a planet, just as a merchant finds the weight of a parcel of goods, whilst the pendulum has become a magic power in the hands of the geologist, enabling him to discover cavities in the bowels of the earth. Our case is similar to these. By observation and calculation of the velocity of sound in our atmosphere, we obtain the ratio of the specific heat of air under constant pressure and under constant volume, and by the help of this number we determine the quantity of heat generated by mechanical work. The heat which arrives from the sun in a given time on a small surface of our globe serves as a basis for the calculation of the whole radiating effect of the sun; and the result of a series of observations and well-founded conclusions is the quantitative determination of those cosmical masses which the sun receives from the space through which he sends forth his rays.

Measured by terrestrial standards, the ascertained number of so many billions of kilograms per minute appears incredible.

[*] This centrifugal motion is perhaps the cause of the repulsion of the tails on comets when in the neighborhood of the sun, as observed by Bessel.

This quantity, however, may be brought nearer to our comprehension by comparison with other cosmical magnitudes. The nearest celestial body to us (the moon) has a mass of about 90,000 trillions of kilograms, and it would therefore cover the expenditure of the sun for from one to two years. The mass of the earth would afford nourishment to the sun for a period of from 60 to 120 years.

To facilitate the appreciation of the masses and the distances occurring in the planetary system, Herschel draws the following picture. Let the sun be represented by a globe 1 metre in diameter. The nearest planet (Mercury) will be about as large as a pepper-corn, 3½ millimetres in thickness, at a distance of 40 metres. 78 and 107 metres distant from the sun will move Venus and the Earth, each 9 millimetres in diameter, or a little larger than a pea. Not much more than a quarter of a metre from the Earth will be the Moon, the size of a mustard seed, 2½ millimetres in diameter. Mars, at a distance of 160 metres, will have about half the diameter of the Earth; and the smaller planets (Vesta, Hebe, Astrea, Juno, Pallas, Ceres, &c.), at a distance of from 250 to 300 metres from the sun, will resemble particles of sand. Jupiter and Saturn, 560 and 1000 metres distant from the centre, will be represented by oranges, 10 and 9 centimetres in diameter. Uranus, of the size of a nut 4 centimetres across, will be 2000 metres; and Neptune, as large as an apple 6 centimetres in diameter, will be nearly twice as distant, or about half a geographical mile away from the sun. From Neptune to the nearest fixed star will be more than 2000 geographical miles.

To complete this picture, it is necessary to imagine finely divided matter grouped in a diversified manner, moving slowly and gradually towards the large central globe, and on its arrival attaching itself thereto; this matter, when favorably illuminated by the sun, represents itself to us as the zodiacal light. This nebulous substance forms also an important part of a creation in which nothing is by chance, but wherein all is arranged with Divine foresight and wisdom.

[To be continued.]

Art. XVI.—*Second Notice of Recent Researches relating to Nebulæ;* by A. Gautier.[1]

Labors of Lord Rosse; First Memoirs.—Since 1827 Lord Rosse has been engaged in the construction of large specula for astronomical telescopes. In 1839 he finished his first telescope, which had a speculum three feet in diameter with a focal distance of 27 feet, and he described the method of constructing it in a me-

[1] Translated for this Journal from the *Bibliothèque Universelle*, for June, 1863.

moir which was inserted in the *Philosophical Transactions* of the Royal Society of London for the year 1840. Afterwards, he undertook to produce specula of larger dimensions, and in 1844 he completed two, six feet in diameter, with a focal distance of 56 feet, for the employment of which he constructed a huge telescope, which he erected in the open air, between two walls to which it was attached, near his country seat at Birr (Castle) or Parsonstown in Ireland, twenty-five leagues southwest of Dublin.

Lord Rosse has been for several years President of the Royal Society of London. In 1850 he published in the Transactions of this ancient and illustrious Society, his first memoir of 15 pages quarto upon his observations of nebulæ, accompanied with four plates representing seventeen of these celestial objects. Before noticing his second memoir upon the same subject, presented to the same Society in 1861, I will mention some details extracted from the preceding memoir.

In the memoir of 1850, Lord Rosse first pointed out the spiral form which he had discovered in many nebulæ, a fact of great importance as throwing new light upon the constitution of those celestial systems.

The beautiful nebula, No. 51 of Messier's catalogue, (No. 1622 of the catalogue published by Sir John Herschel, in the *Phil. Trans.* for 1833,) is situated in the constellation *Canes Venatici*, near *Bootes*, in about $13^h\ 23^m$ of right ascension and 48° of north declination. It had been described by Messier as a double nebula containing stars; by Sir William Herschel as a brilliant nebula surrounded at a little distance by a sort of halo or glory, and having a companion near. Sir John Herschel had further observed the division of the southwest border of the annulus into two branches. Lord Rosse, in 1845, was the first to discover the spiral structure forming many circumvolutions without curves returning regularly upon themselves. The sketch which he gave from many observations with the telescope of six feet diameter presents a dozen distinct circumvolutions more or less extended.

"We see," said this astronomer, "that every step of progress in optics exhibits a more complicated structure in this nebula, and it is more and more difficult to explain it by the dynamical laws which prevail in our solar system. The second nebula is evidently connected with the larger one, but the form of the nebula being such as is represented in the figure, this connection increases the difficulty of conceiving of any hypothesis to explain it. It appears in the highest degree improbable that such a system exists without interior movement. It is possible to unite to this idea that of a resisting medium, but the supposition of an equilibrium purely statical is not admissible. Some posi-

tive measurements, whether of changes of brightness, or of form, or of variations of position, will therefore be most highly interesting, but they present great difficulties." Mr. Johnston Stoney, whom Lord Rosse associated with himself in these observations, meanwhile, in the spring of 1849 and 1850, made micrometric measurements, assigning in the present memoir the relative positions of different stars situated in the nebula, No. 51 of Messier, as referred to its central nucleus. The nebula No. 99 of Messier, (No. 1173 of Sir John Herschel's catalogue,) situated about 12^h 10^m of right ascension and 15° of northern declination, has also given opportunity for some similar measurements. This is the second nebula in which Lord Rosse has shown a very distinct spiral structure. He has described also, in his memoir of 1850, twelve fainter nebulæ of the same class, and he surmised that some others are of the same kind. He described and figured in this memoir five new annular nebulæ, in addition to the two already contained in the catalogue of Sir John Herschel; also some more stars called nebulous, and other nebulæ of an elongated lenticular form, three of which are represented in the plates attached to this memoir.

The Latest Memoir of Lord Rosse.—The new memoir presented by Lord Rosse to the Royal Society of London in June 1861, and which appeared in 1862, in Part III of the Philosophical Transactions for 1861, consists of 65 pages quarto. It is accompanied by seven plates, one of which is devoted to the telescope of six feet aperture, while the others represent 43 nebulæ. This memoir is the result of seven years' observations made with his great telescope; but, as Lord Rosse remarks, in a climate so foggy as Ireland the labor of a year, measured by the number of hours in which it is possible to make good observations of nebulæ, is not considerable.

" Here," he says, "in winter celestial objects are usually most distinct, and the sky is the darkest before eleven o'clock at night; the sky however soon becomes luminous and the details of the nebulæ which are less distinct disappear. In spring and autumn the change of light is not so prompt nor so decided, but the nights are shorter. Guided by the admirable catalogue of Sir John Herschel (containing the positions and a summary description of 2306 nebulæ) we have examined nearly all the more brilliant nebulæ known, with the exception of a few in the vicinity of the pole, and have observed a great part of the fainter ones. We have not especially sought for new nebulæ, but yet meanwhile many such have been accidentally discovered in the immediate neighborhood of nebulæ already well known, but they are for the most part very faint objects presenting little interest. In all cases where any peculiarity has been discovered, such, for example, as a spiral curvature, lines or dark spaces, a sketch has been made, and the most remarkable objects have been submitted to a detailed examination, on favorable nights, sometimes with the aid of a micrometer. In our eminently variable climate, when we em-

ploy high magnifying powers and large apertures, vision is more or less altered, either by the tremor of the air, or by the vapor, and the state of the air varies enormously, in both these respects, from one night to another, and even from hour to hour. Neither is the performance of the speculum uniform. Sudden alterations of temperature in this humid climate produce deposits of dew, and the speculum gradually becomes tarnished. It is possible to remedy this by artificial heating, but that would produce other difficulties and we have not had recourse to that expedient. It is thus difficult to say that any celestial object has been examined under circumstances altogether favorable. Nevertheless as it is not probable that we should be able to add much to the details already obtained with the nebulæ, unless it be under conditions of the atmosphere particularly advantageous and very rare, I have decided not to defer longer the presentation of this memoir."

The author begins with numerous details of the processes adopted for casting and polishing large specula as well as the method adopted for mounting them. As I have previously had occasion to mention it in my Notice of 1845, I will not follow out this subject, which has more interest and importance for makers of instruments of this kind than for the public.

I will merely mention that the specula made by Lord Rosse are formed of an alloy of a little more than two parts of copper to one part of tin, the specific gravity of the alloy being 8·8. The mirrors of three feet in diameter weigh about 1200 French pounds, and those of six feet diameter weigh 4 tons or 8000 pounds. The mounting is not equatorial and the telescope does not move very much from the meridian. In order to be able to use it constantly it is convenient to have two specula to be used alternately. Lord Rosse has made use of the Newtonian form, employing a small reflecting mirror, inclined at an angle of 45°, which permits the observer to place himself at one side of the instrument with an eyepiece. He estimates that a linear magnifying power of about 1300 times is the largest that can generally be used with advantage in his telescopes, for the observation of nebulæ; but he has occasionally made use of a power of more than 2000 times for discovering small stars with the telescope of 3 feet aperture. On some occasions the 6 feet reflector has admitted even more than this; but in the climate of Ireland those occasions are rare and of short duration. The author thinks that telescopes of even greater dimensions may be constructed and employed with advantage in favorable climates, for studying the details of nebulæ of feeble light, as well as to recognize a great number that are double or multiple. He also thinks that it would be well to employ silver for the second reflection. Lord Rosse says he has often experienced much difficulty in choosing between numerous observations, in view of the uncertainty which sometimes exists in regard to the reality of a fact, presented sometimes in one way and sometimes in another, accord-

ing to the time of observation. He is disposed in general rather to describe in detail the parts of nebulæ of feeble light than to determine their resolvability into stars. He has made use successively of many mirrors of six feet diameter two or three of which have been as perfect as the first; but, considering the hard labor required for removing and repolishing such large specula, he acknowledges that a considerable mass of observations have been made with mirrors in a condition evidently imperfect. He has frequently been able to show, with a telescope of three feet diameter, a case of resolvability, while no trace of this kind has been perceived by the telescope of six feet aperture in its ordinary condition. Questions relating to the structure of the nuclei of nebulæ furnish remarkable analogies. When they have such nuclei they present sometimes a gentle and sometimes a rapid increase of light towards the centre, and they sometimes manifest at this point a stellar appearance which might be considered as a real star; but the impressions made upon the eye at the moment of observation cannot be admitted in all cases as real physical facts. The author thinks it proper however to make the following remark. Among the Clusters there may be some, placed at a great distance or examined with an instrument of insufficient optical power, which may be regarded as nebulæ with centres of light or of different condensation; but there does not appear to be any cluster having a central star of such great brilliancy that it could under all circumstances be arranged in the class of objects having a star at the centre.

Lord Rosse has made observations in connection with the brothers Johnston and Bindon Stoney, and more recently with Mr. Mitchell; the greater part of these observations have been made in his absence, but in his opinion they are worthy of none the less confidence. Each of these gentlemen has made observations for about two years, and has made elaborate drawings of some remakable nebulæ. Bindon Stoney, in 1850 and 1851, made micrometer measurements of nebulæ Nos. 1622 and 2060 of Sir John Herschel's catalogue. The comparison of the results with those obtained by Otto Struve and communicated by him to Lord Rosse, in a letter dated at Poulkova, June 2d, 1851, and inserted in the memoir under consideration, present an accordance generally satisfactory. Lord Rosse regrets not having engaged Mr. Mitchell, who has been charged with these observations since the month of May, 1852, to continue the micrometer measurements, the arrangement of the materials of his last memoir giving him occasion to suspect some changes in the direction of certain parts of the nebulæ, especially in that of No. 1905 of Herschel's catalogue.

The second part of this memoir is composed of a brief *résumé* of observations descriptive of the greater part of the nebulæ of

Sir John Herschel's catalogue of 1833, arranged in the order adopted by that catalogue, that is, according to their right ascensions. These observations are frequently accompanied, in the text itself, by designs rapidly executed upon wood, representing the characteristics of some of the nebulæ, among which are fifteen having a structure distinctly spiral.

The memoir is concluded with a list of thirty-five nebulæ of Herschel's catalogue which have not been rediscovered in the course of the ordinary observations of Lord Rosse and his assistants, and to which it is therefore desirable that the attention of astronomers should be directed anew.

The drawings of remarkable nebulæ have been very faithfully engraved by Mr. Basire, as were those of the first memoir. Lord Rosse observes however that the stars are frequently figured too large.

From the preceding analysis it appears that the last memoir of Lord Rosse, without presenting any very remarkable new facts, has considerable importance as completing the researches upon nebulæ visible in Ireland, undertaken by him and his assistants. We must admire the persevering energy displayed by Lord Rosse, in such a social position as his, whether in the construction of his great telescopes, or in employing them to the best advantage, as well as the candor with which he has described in detail his processes of construction, and pointed out the imperfections which may be noticed in observations of so difficult and delicate a character in such a cloudy climate.

Lord Rosse agrees fully, in his appreciation of the great difficulties to which the observation of nebulæ give rise, with the two astronomers who have recently been engaged with him—Messrs. Otto Struve and D'Arrest, as may be seen in the brief notice of their labors which I inserted in the *Archives* for September, 1862.

It does not appear that the observations thus far confirm the ideas, previously put forth by some savans, as to the probability of a gradual process of concentration of the luminous matter in these celestial objects. The spiral structure of a goodly number of nebulæ accords but little with these ideas. Lord Rosse remarks, in his first memoir upon this subject, that this structure seems to indicate the presence of dynamical laws, to the determination of which we may at length arrive; but he does not think that in the actual state of our knowledge it is possible to form even plausible conjectures of this kind, and the more he has observed the more this investigation has appeared to him mysterious and unapproachable.

II. *Various Announcements and Articles relating to Nebulæ.*—Mr. D'Arrest has announced, in No. 1379 of the *Astr. Nachrichten*, the existence of a third variable nebula, north of the constellation Taurus. This nebula had been seen before at the observa-

tory of Bonn, by Messrs. Schönfeld and Krüger, in 1855 and 1856, and in America, by Mr. Tuttle, in 1859. It was then visible with a comet seeker of 34 lines aperture, but in 1862 Mr. D'Arrest found that it was seen with difficulty at Copenhagen with the great telescope of his observatory.

Mr. Schönfeld, acting director of the observatory of Mannheim, published in No. 1391 of the *Astr. Nachrichten* a notice of the observations upon nebulæ recorded in the surveys of the heavens by zones made at the observatory of Bonn, in which he denies the variability of the light of this same nebula of Taurus, which he had observed without difficulty, in September, 1862, with a telescope of eight feet focal length. The author regards the variability of the second nebula of this kind in Taurus as no more certain than that of the one discovered in 1855 by Mr. Tempel, in the Pleiades, near the star Merope, and designated as variable by Mr. D'Arrest, in No. 1378 of the *Astr. Nachrichten*, Messrs. Chacornac having also observed it with him, in September, 1862. Mr. Schönfeld considers that the variability of the atmosphere and of the eye of the observer may occasion very different impressions from nebulæ of feeble and somewhat diffused light.

Doctor Auwers, astronomer at Göttingen, in a letter which follows the preceding article, takes the same view as Mr. Schönfeld. From his own observations, made at Königsberg in 1858, and at Göttingen in 1861, he admits indeed the variability of the light of the nebula discovered in Taurus by Mr. Hind in 1852, which appears to have attained its greatest brilliancy in 1856, and to have disappeared in 1860, but he does not credit the variability of the other two nebulæ in Taurus. He says, "I have frequently observed, among other occasions at one of the appearances of Encke's comet, that celestial objects somewhat extended, with feeble and diffused light, are more easily recognized with small optical instruments than with the larger ones, the field of vision of these last being in general quite limited." He adds that in September, 1862, he clearly distinguished the two nebulæ in question, with a comet seeker of two feet focal length.

Dr. Auwers has also inserted in No. 1392, *Astr. Nachr.*, a catalogue of the exact positions in 1860 of forty nebulæ as observed with the heliometer of the observatory of Königsberg. This catalogue is accompanied with various remarks, and the comparison of the positions given with those of the same nebulæ in the catalogues already published by Messrs. Langier and D'Arrest. These comparisons do not appear to show any changes of position.

Doctor Winnecke, in a letter dated at the Observatory of Poulkova and inserted in No. 1397 of *Ast. Nachr.*, confirms the opinion announced above, that small telescopes frequently enable us

to distinguish nebulæ better than the larger instruments. He does not think the variability of the last two nebulæ of Taurus has been distinctly shown.

Mr. D'Arrest, in an article published in No. 1398 *Astr. Nachr.*, acknowledges the variability of the nebula near Merope, and points out another nebula marked by Jeaurat to the north of Pleïone, in a chart of the Pleiades published by him in the *Mémoires de l'Académie des Sciences* of Paris, for 1779, which has not yet been rediscovered. He presumes, therefore, that this region of the heavens is especially subject to variations of light.

The same astronomer has announced, in No. 1407 *Astr. Nachr.*, that Sir John Herschel is preparing a new general catalogue of nebulæ from observations both ancient and modern, and he gives on this occasion a list of corrections of the catalogue of 1833, resulting from his own observations and those of Messrs. Auwers and Marth, which Sir John Herschel will be able to make use of in his new work.

The later numbers of the *Monthly Notices* of the Astronomical Society of London contain no articles relating to nebulæ. I will cite only one article by F. Abbott, dated at his private observatory at Hobart-Town, (Australia,) in May, 1862, and published in the *Monthly Notices*, No. 1, Vol. 23, page 32. This article, presented to the Society at its session Nov. 14, 1862, with a drawing which has not been reproduced in the *Monthly Notices*, is devoted to a cluster of stars in the Southern Cross designated by the Greek letter *Kappa*. "This beautiful cluster," says Mr. Abbott, "which Sir John Herschel stated to be composed of 50 or 100 stars of different colors is scarcely visible with the naked eye; but viewed with a telescope it is one of the most brilliant and interesting objects in the southern heavens, not only for the extreme beauty of color and arrangement which distinguish it, but also for certain changes which appear to have taken place in the number, position and color, of the stars which compose it, since it was observed at Feldhausen, near the Cape of Good Hope, by Sir John Herschel, about the year 1835."

The seventy-five stars found in the drawing of Mr. Abbott have been observed and their positions determined by him, either with a telescope of five feet focal length, furnished with an excellent achromatic object glass of 4¼ inches diameter, or with an achromatic telescope of seven feet, made by Dolland. The magnifying power employed for determining their positions was one hundred and thirty-five, and that for the colors only twenty-seven diameters. Many of the stars appear to have changed their positions, and a considerable number of those figured in the drawing of Mr. Abbott are not found in the description and representation made by Sir John Herschel.

Several of the stars have preserved their color, but according to Mr. Abbott, most of them have changed; all the small stars, from the tenth to the fourteenth magnitude, have the color of Prussian blue, with more or less of a tint of red or green mixed with the blue.

Mr. Bond, of Cambridge, U. S., continues his observations upon nebulæ. According to a note added to the English translation of my review of this subject, in September, 1862, (published in the *American Journal of Science*, for January, 1863,) this astronomer is now preparing to publish a complete account of fourteen years observations upon the nebula of Orion made with the telescope of Harvard College; and the comparisons which will result will very probably furnish new and interesting remarks. In another note, the editors of the *American Journal* say that they are authorized to state, contrary to an assertion of Otto Struve, reported in my Notice, that Mr. Bond has distinctly recognized and recorded, in five original sketches drawn in 1847 and 1848, the *nebulous bridge*, situated upon the *Sinus Magnus* in one of the regions of the nebula of Orion, and that this bridge is figured in most of his more recent sketches.

No. 1383, *Astr. Nachr.*, contains a new plate upon a small scale of this same nebula of Orion, and also numerous stars situated upon and around it, drawn in 1861, by W. Tempel, from his own observations made with a telescope of four inches aperture, with magnifying powers of only 20 to 40 diameters.

Finally, I will report a note by Chacornac, entitled "*Nébuleuse variable de ζ du Taureau*," presented by Mr. Le Verrier to the Academy of Sciences of Paris at its session April 6, 1863, and inserted in the *Comptes Rendu* of that meeting, t. 56, p. 637.

Mr. Chacornac, at Marseilles, in the latter part of 1853 and the first part of 1854, noticed a star of the eleventh magnitude situated at about $5^h\ 28\frac{1}{2}^m$ of right ascension and 21° 7′ of northern declination, without perceiving any nebula at that point; but he could not see any at Paris near the meridian towards the end of 1854, with a telescope of twenty-five centimeters aperture, although the atmosphere was very transparent.

The 19th of October, 1855, he observed a faint nebula projecting itself upon this same small star very near to ζ of Taurus. November 10th, the nebula had changed neither its place, dimensions, or form. January 27th, 1856, it appeared to him quite brilliant, presenting the appearance of a transparent cloud which seemed to reflect the light of ζ of Taurus; its appearance, totally different from that of the nebula No. 357, (Herschel, 2,) gave no idea of stellar points visible throughout the whole extent of its surface. It was like a light *cirro-stratus*, striped with parallel bands, presenting a form nearly rectangular, the greater side of which measured an arc of 3½ minutes, and the smaller arc 2½ minutes.

November 20th, 1862, Mr. Chacornac could no longer find the least trace of this nebula, while the small star upon which it was projected did not present any variation of brightness; and the nebula has since been invisible with the instruments of the Imperial Observatory of Paris.

We see by the preceding Notices what a degree of activity and interest the researches upon nebulæ now inspire, and also how many difficulties they present. It will not probably be very long before we may hope to obtain a solution of some of the important questions to which they have given rise.

ART. XVIII.—*On the action of very weak Electric Light on the Iodized Plate;* by OGDEN N. ROOD, Professor of Physics in Columbia College.

ABOUT three years ago Dove received from Mr. Gunther of Berlin a photograph of a bronze statue of an amazon holding a lance in a perpendicular position, Mr. G. at the same time calling his attention to a singular mark in the picture, which was not in the original. The lance was properly delineated on the negative plate, but in addition, just at its tip, a dark streak was visible, though nothing of the kind had been observed at the time of taking the picture. Careful examination of the plate showed two other analogous marks. Dove thought that these singular appearances might have been caused by the presence of invisible electric brushes, resting on these points, and undertook some experiments to determine whether weak electric light could be photographed. Geisler tubes were used in a *dark* room, and with the aid of Gunther, he succeeded in obtaining good photographs of the stratified discharge,[1] as Prof. Wm. B. Rogers[2] had done some months previously.

This led me to attempt the study of the *electric brush* by the aid of photography, but as its light is incomparably weaker than that from a Geisler tube, I found that no impression was produced on the sensitive plate. Being unwilling to abandon the matter, a very sensitive collodion was then prepared from pyroxyline, in which the cotton fibre was somewhat disintegrated, and by its use I finally obtained good photographs of the positive, as well as of the negative brush. An ordinary camera was employed, and the exposure lasted seven minutes. The minute photographs were then enlarged as usual, and prints made from the enlarged negatives.

[1] Pogg. Annalen, vol. cxiii, No. vii. [2] This Journal, xxx, 387.

The positive electrical brush consists, as is well known, of a short stem with widely branching ramifications; these latter are very faint even in the darkest room, and failed to produce an impression on the plate. The stem of the brush, which is somewhat more luminous, delineated itself as represented on the wood-cut, fig. 1, which is from a photograph magnified ten diameters.

1.

Positive electric brush.

2.

Negative electric brush.

It is well known that the negative brush is much smaller than the positive, and it is often spoken of as a star or minute point of light; the photograph, however, shows that this is not the case, but that its structure is analogous to that of the positive brush, only that the ramification begins lower down on the stem, as it were, nearly at its root, as is seen in the wood-cut, fig. 2, which is from a magnified photograph.

Action of weak electric light on the plate in the presence of daylight.—The Geisler tubes in the physical cabinet of the college enabled me now to put the probability of Dove's suggestion to the test of experiment; some of these were connected with an induction coil and photographed in broad daylight, when it was found that the image formed by the electric discharge could be easily traced through the length of the tubes, and that even the stratification was still partially visible. In these cases, however, the electric light was still visible to the eye during the discharges.

Accordingly, to make an exact experiment on this point, a sheet of white paper was placed behind one of these tubes and white daylight reflected through it towards the camera. The intensity of this reflected light was so regulated that the bright envelope of the platinum wire was nearly invisible, and the diffused violet light, at a greater distance from the wire, *absolutely* invisible. Nevertheless an intense photographic image of the envelope, and a very distinct image of the diffused electric light was easily obtained, thus proving conclusively the correctness of Dove's assumption, that electric light, which in ordinary daylight could not be seen, owing to its feeble illuminating power, might yet make itself very evident on the iodized plate, by virtue of its high percentage of chemical rays.

This experiment is indeed a very striking proof of the chemical activity of the electric light, the more so, as according to some of my experiments, the iodized plate is by no means as sensitive to slight differences in illumination as the human eye.

Among the Geisler tubes belonging to the college I found one in which bulbs of uranium glass were alternated with small tubes of plain colorless glass. When the room was darkened, and the electric discharge passed through it, owing to their fluorescence the balls shone very brightly, invisible or faintly visible light being converted into bright green light. On taking a photograph of the tube, it was quite surprising to see how blank were the spaces on the plate, where the images of the green bulbs had fallen; after an exposure of four minutes only one of the bulbs could be faintly traced, though other portions of the discharge were represented by an intense deposit of silver. This shows how completely the electric light is divested of its chemical power by dispersion from a thin stratum of this kind of glass.

It might be supposed that uranium glass would cut off most of the chemical rays, when ordinary daylight was *transmitted* through it, but this was not found to be the case. I placed the Geisler tube with the uranium bulbs, so that the light from a bright sky fell directly through it on the lens of the camera, the entire aperture of the lens (a "portrait combination" of six inches focal length) was used, and the exposure lasted one minute. An examination of the negative plate showed that the thin walls of the uranium bulbs had merely *diminished* to some extent the chemical power of the rays passing through them. The same experiment with a plate of uranium glass two-tenths of an inch in thickness gave a result like in kind only differing in degree: the chemical intensity of the light being diminished about one-half. This shows, in accordance with theory, that it is mainly the *dispersed* light which has lost its chemical power, and that through a plate of even this thickness many chemical rays still penetrate.

A photograph of another Geisler tube, in which the interior discharge tube was surrounded by a solution of sulphate of quinine, was also taken: this liquid by its fluorescent property diminished, of course, the intensity of chemical action of the electric light, but by no means to the same extent as the uranium glass.

Feb. 3d, 1864.

ART. XIX.—*On the Invisibility of Nebulous Matter;* by D. TROWBRIDGE.

IT has generally been supposed that if nebulous matter, in the proper sense of the word, or cosmical vapor, exists in the heavens, and within reach of our telescopes, it will be visible to the eye, with suitable optical aid. It is proposed to show in this article, with some plausibility, that this is an erroneous idea, except in some particular cases.

Comets are the only celestial objects, whose physical constitution is approximately understood, that afford us anything like a distinct notion of what nebulous matter is. By far the greater proportion of these bodies are composed of materials so extremely rare that the solar rays can penetrate completely through the denser portion of their bodies, and the light in some cases seems to suffer scarcely any diminution in intensity. Yet these bodies, which perhaps would weigh at the surface of the earth but a few ounces, or but a few pounds, are distinctly visible with the smallest optical aid, and even, under favorable circumstances, with the naked eye. Sir John Herschel says, of this class of comets, that the most unsubstantial clouds which float in the higher regions of our atmosphere, must be looked upon as dense and massive bodies in comparison with the almost spiritual texture of these light bodies. A cloud composed of materials so rare, and whose distance from us did not exceed fifteen or twenty miles, would scarcely be visible. A comet, however, will be visible when its distance from us is many millions of miles.

What conclusion can we draw from these facts? Do they not indicate that comets do not shine wholly by reflected light? On the 3d of July, 1819, Arago made an attempt to analyze the light of comets, by applying his polariscope to the great comet of 1819. The instrument showed unmistakable signs of polarized light, and, therefore, of reflected sun-light. Similar observations on Halley's comet, in 1835, more clearly indicated the existence of polarized light. "These beautiful experiments still leave it undecided, whether, in addition to this reflected solar light, comets may not have light of their own. Even in the case of the planets, as, for instance, in Venus, an evolution of independent light seems very probable."[1]

"The variable intensity of light in comets cannot always be explained by the position of their orbits, and their distance from the sun."[2] After mentioning Arago's observations, with his polariscope, on Halley's comet, in 1835, Mr. Hind says, "Still the variation in the intensity of light is not universally such as should follow if the comet merely reflected the sun's rays under

[1] Cosmos, vol. i, pp. 90, 91. Bohn's edition. [2] Cosmos, vol. i, p. 91.

certain permanent conditions, and we are under the necessity of looking to physical causes inherent in the body itself for an explanation of some few observations which appear irreconcilable with the theory of reflected solar light."[3] "The molecular conditions of the head or nucleus, so seldom possessing a definite outline, as well as the tail of the comet, is rendered so much the more mysterious from the fact that it causes no refraction."[4]

I have collected these facts together to show that reflected solar light cannot completely explain, at present, all the phenomena of the light of comets. Besides the above observations, it may be added that the visibility of comets in the day time, and even when near the sun, also indicates a light-generating process in the comet; for otherwise we must suppose them capable of reflecting more light than the planets. Indeed, it is difficult to see how a body can maintain its gaseous or nebulous state without being kept at a high temperature, and therefore, having within itself a light-producing cause. Assuming, then, that there is a light-generating process that is active in comets, let us see what use can be made of it, and whether it will afford us any light on the subject of the visibility of nebulous matter.

It is now a well-established fact that the heads of comets contract in dimensions as they approach the sun. This was first noticed by Hevelius, but was not established till many years afterwards. What is the cause of this condensation of cometary matter as the comet approaches the sun? Whatever may be the cause of it, we know that it has a great effect on the visibility of the comet. Is it not possible that the solar rays, acting chemically or otherwise, excites in the comet those principles which cause it to send out in greater abundance, direct light? We know that a comet will increase in brightness with great rapidity as it approaches the sun; and also decrease in brilliancy with equal rapidity in general, as it recedes from the sun, so that the fainter comets disappear in the best telescopes, when, their apparent dimensions only being considered, they ought to remain visible. The dilatation of the cometary volume seems to prevent the comet from sending out much light, either reflected or direct.

Applying these principles to *nebulæ* proper, we must conclude that nebulous vapor is necessarily too diffuse, has too little density to be visible, when far removed from us. According to this, then, nebulæ cannot in general be visible, unless they are considerably condensed, and perhaps actually converted into stars. It is perfectly evident that the luminosity of nebulous vapor must be very feeble, even where the light is inherent. The process of condensation only, then, can render nebulous matter visible through our telescopes. Will not this account for the fact that

[3] Hind's Treatise on Comets, p. 24. [4] Cosmos, vol. iv, p. 548.

higher telescopic power resolves *previous* nebulæ? It is very doubtful whether our best telescopes will ever be able to bring into view any real nebulæ. According to the Nebular Hypothesis, we should not expect to find any large collection of nebulous matter in the vicinity of our system, either planetary or stellar, and ages may pass before our system, in its progress through space, will come near any of the small patches that may exist, so as to render them visible to us.

Perry City, N. Y., Aug. 31st, 1863.

Note.—The influence of the magnetic power of the sun, may be a potent cause to render comets visible as they approach the great central luminary. It is a fact derived from observation, that the sun affects the magnetic needle, and that its period is closely connected with the period of the solar spots. It is also known that the *auroras* influence the needle; and that they are subject to the same law of periodicity as the solar spots, and thus seem to be connected with solar influence. The effect of the auroras is evidently light-producing.

ART. XX.—*Remarks on the family Pteriidæ, (=Aviculidæ) with descriptions of some new fossil genera;* by F. B. MEEK.

THE existing genera of the family Pteriidæ form a group at once so natural, and so distinctly defined, that conchologists meet with little difficulty in deciding what particular genera it should include.[1] When we undertake to classify the more numerous extinct genera, however, which were introduced, lived out their term, and passed out of existence at various periods during the immense interval of time between the first introduction of this type of life and our present epoch, the case is very different; for we find amongst the vast numbers of fossil species, types presenting various intermediate gradations between the modern

[1] Perhaps the only question in regard to the limits of this family, as known in our existing seas, respecting which late writers on conchology differ, is, whether or not it should include the *Pinna* group. Some think it should, while others make a distinct family for the reception of *Atrina* and *Pinna*. The latter view seems to be more nearly correct; but whether we view the group as a family or a subfamily, it should probably include the Jurassic genus *Trichites*. There is also a curious Permian genus that may belong here. Its type is *Pinna prisca*, Munster, = *Avicula pinnæformis*, Geinitz, (*Dyas*, p. 77, pl. xiv, fig. 1, 2, 3, 4). For this genus I would propose the name, AVICULOPINNA.

The typical species is an elongated, thin, nearly or quite equivalve shell, with the narrow tapering general form, and very long hinge line of *Pinna*;—from which it differs in not having its beaks terminal, but set back some distance from the rather obtusely pointed anterior extremity. The beaks, however, are depressed and scarcely distinct from the cardinal margin, and the general aspect of the shell seems to be intermediate between that of *Pinna*, and *Avicula Modiola*. It would be interesting to know whether or not it has a prismatic structure; if not, it will most probably be found to belong to the *Mytilidæ*.

representatives of this and some of the allied groups.[1] For instance, no conchologist could be for a moment in doubt whether any particular species or genus of our existing Mollusks belongs more properly to the *Aviculidæ* or to the *Pectenidæ*. Yet in tracing these two families by their fossil shells back into the distant past, we meet with various types presenting such an assemblage of characters as to often render their proper distribution more difficult; especially since we have only the light of analogy to guide us in our conclusions respecting the structure of the softer parts of these extinct forms. Some of these peculiar species were formerly referred by many paleontologists to the genus *Pecten*, and by others to *Avicula;* and even now, since the genus *Aviculopecten* has been established for their reception, authors are by no means agreed whether this genus should be classed with the *Pectenidæ* or the *Aviculidæ*.

Again, no one having even a small amount of conchological knowledge need be at a loss in deciding to which of the two families, *Arcidæ* or *Aviculidæ*, any of our existing species of bivalves properly belong. Yet in passing from group to group of the *Arcidæ*, from the recent typical examples, through some of the other modern forms, and thence through various extinct types, it will be observed that the hinge plates, or denticles, become more and more oblique, until in some of the Paleozoic genera, such as *Cyrtodonta*, *Vanuxemia*, *Dolabra*,[2] &c., only a few obscure divisions are to be seen at the remotest extremities of the hinge, ranging nearly or quite parallel to the cardinal margin, as in *Pterinia*, *Bakevellia*, and some of the other genera apparently belonging to the *Aviculidæ*. In addition to this, in many of the extinct groups of *Aviculidæ*, such for instance as *Gryphorhynchus*, *Myalina*, *Bakevellia*, &c., there is as well a developed cardinal area, as we generally see in the *Arcidæ;* while this area, in several of these ancient types, is provided with cartilage furrows, as in the *Arcidæ*. Again, in *Pterinia*, and some species of *Bakevellia*, we see the anterior muscular impression comparatively so well developed, that one can scarcely believe it was not made by a true adductor; while the eccentric position of the posterior muscular impression would seem also to favor the same conclusion; and yet in all their other known characters these forms agree with the *Aviculidæ*.

In another direction, some of these ancient groups of *Aviculidæ*

[1] Whether the introduction, and gradual dying out of the various forms presenting these intermediate characters resulted from the operation of a law of nature, like that termed by Dr. Darwin "natural selection," or any other, or from repeated miraculous creations, it is not the object of this paper to discuss.

[2] As typified by *Cucullæa angusta* Sowerby, which must now be regarded as the type of *Dolabra*, since Prof. King has separated from that genus as first proposed, the genus *Schizodus*. *Dolabra? alpina* Hall, (Iowa Report, i, part ii, pl. 29 fig. 2) is a *Schizodus*.

seem to show a disposition to shade off towards the *Mytilidæ* or *Dreissenidæ.* Amongst the Carboniferous and Permian species of *Myalina*, for instance, we see species presenting exactly the form and other general external appearances of the existing genera *Mytilus* and *Dreissena*, to which even yet some paleontologists will persist in referring them. On a closer inspection, however, these Carboniferous and Permian species, when we can find them with the two valves united, are seen to be always a little inequivalve, while their hinge also differs from that of the *Mytilidæ* and *Dreissenidæ* in having a flat area with longitudinal cartilage furrows. In addition to these differences, I have discovered that the shell structure of at least two species of *Myalina*, (*M. perattennuata* Meek & Hayden, and *M. angulata* Meek & Worthen,) is minutely prismatic, like the outer portion of the shell in the true *Aviculas.* It is true that the same structure has also been observed by Dr. Carpenter in the inner layer of *Dreissena*, but the unquestionable inequivalve character of *Myalina*, in connection with its peculiar striated cartilage area, and the fact that these shells are always found associated with marine types, are sufficient evidences that they have no very close affinities to *Dreissena.*

From an attentive study of the various fossil and recent groups apparently falling within the *Aviculidæ* or more properly *Pteriidæ*,[4] the writer has, in the manuscript work on the Paleontology of the Upper Missouri country, to be published jointly with Dr. Hayden, proposed the following diagnoses of the family *Pteriidæ*, and the subordinate groups into which it seems to be divisible :—

Family PTERIIDÆ (or *Aviculidæ*).

Shell inequivalve, inequilateral, composed of an inner laminated pearly layer, and an outer prismatic substance; left or upper valve always more convex than the other. Anterior margin of the right valve generally more or less sinuous for the passage of the byssus. Cartilage submarginal, simple, and placed in a single cavity or depression near the beaks, or divided and distributed in a series of furrows crossing the cardinal facet at right angles,—or, in some of the older fossil genera, occupying linear furrows in the cardinal area or facet, ranging more or less nearly parallel to the hinge line. Hinge with or without teeth. Scar of adductor muscle large and usually subcentral; anterior muscular impression generally small and placed near the beak. Pallial line simple, often irregularly dotted.

[4] Since *Scopoli's* name, *Pteria*, was regularly established in 1779; while Klein's name, *Avicula*, was not affirmed by any author understanding or recognizing the Linnæan ideas of genera and species, until Bruguiere adopted it in 1789. I think Dr. Gray is right in restoring Scopoli's name, *Pteria*, for this genus.

The animal in the existing typical genus has the mantle-margins freely open and doubly fringed; foot small, grooved, and having the power of spinning a byssus; palpi large; gills two on each side, crescent shaped, free or connected with each other posteriorly, and to the mantle.

The foregoing diagnosis of the shells of this family is framed so as to include species belonging to three subordinate groups, the first of which, so far as known to the writer, has no living representatives, and seems to have been mainly confined to the Paleozoic epoch. The other two groups (the *Pteriinæ* or *Aviculinæ* and *Melininæ*) are both represented by living species in our existing seas. . These three sections or subfamilies may be characterized as follows:—

1. Pteriniinæ, (or *Pterinia* group).

Cartilage apparently occupying a series of linear furrows, ranging more or less nearly parallel to the cardinal margin, in a usually broad, flattened cardinal facet or area. Anterior muscular scar sometimes moderately developed, and deep.

Includes *Pterinia*, *Myalina*, *Ambonychia*, and probably *Actinodesma*, *Gryphorhynchus*, and several undefined Paleozoic groups. A part of the species referred to the genus *Megambonia*[6] will probably be found to belong to some genus of this group, if not indeed to the genus *Pterinia*, though the typical species appear to belong to the *Arcidæ*.

2. Pteriinæ, (or *Aviculinæ*).

Cartilage mainly or entirely confined to a single, more or less defined, depression or cavity behind the beaks. Anterior muscular impression very small.

Includes *Pteroperna*, *Pteria* (or *Avicula*), *Margaritifera*, *Malleus*, *Aucella* and *Eumicrotis*. The following extinct genera also probably belong here, viz:—*Monotis*, *Halobia*, *Pteronites* and *Posidonomya*, with apparently some undescribed fossil genera.

3. Melininæ, (*Perna* or *Isognomon* group.)

Cartilage divided and distributed along the hinge in a series of furrows crossing the cardinal area at right angles to the hinge line. Anterior muscular scar generally very small.

Includes *Crenatula*, *Melina* (=*Perna* Brug., not Adanson), *Bakevellia*, *Gervillia*, *Inoceramus* and *Pulvinites*.

The first two of these sections seem to be more nearly related to each other than either is to the third; and it is not improbable that they will be found connected by a few Triassic and Jurassic species presenting intermediate characters, when the hinge and interior of a greater number of fossil species are known. The Jurassic genus *Pteroperna*, for instance, has hinge teeth analogous to those of *Pterinia*, with apparently a cavity or depression for a cartilage similar to that of *Avicula*. Such exceptional cases, however, cannot be urged as a reason for not recog-

[6] *Megambonia aviculoides*, and *M. lamellosa* Hall, for instance.

nizing the convenience of sections or intermediate groups between families and genera, for it is highly probable that if we knew all the characters of all the species that ever existed, from the beginning of animal life to the present epoch, we should find all our groups blending imperceptibly together; or at least far from being so sharply defined as they appear in works on natural history.

The Pterinia group, or subfamily, probably includes most of the Paleozoic species usually referred to *Avicula*, especially those from the Silurian and Devonian rocks. Indeed, I very much doubt the existence, during the deposition of the Paleozoic rocks, of true *Aviculas*, as that genus is known to conchologists, and typified by the existing *A. Hirundo*. At any rate, I have never seen a specimen, nor can I remember a figure, of any species showing the hinge of a true *Avicula*, from any of our American Paleozoic rocks. So far as my knowledge extends, all the Silurian and Devonian species, the hinge in which has been seen, want the cartilage cavity of the modern *Aviculas*, and have the striated hinge facet, or the oblique hinge teeth, (one or the other or both) of *Pterinia*, more or less distinctly marked. In addition to this, most of the Silurian and Devonian, and many of the Carboniferous species, the hinge in which is unknown, present more the external appearance of the European species figured by Goldfuss and others, in which the internal characters of *Pterinia* are known to exist.

Prof. McCoy, some time since, referred three of our American Paleozoic species,—*A. demissa*, *A. pleuroptera*, and *A. subfalcata*, to *Pterinia*;—and the figures of *A. securiformis* Hall show the broad striated cardinal facet of that genus. I have also ascertained, from the examination of a very fine natural cast of the interior of *Avicula Flabella* Conrad, from the Hamilton Group, of Cayuga Co., N. Y., that it presents all the characters of a true typical *Pterinia*. The specimen examined is a cast of a left valve, showing the impression of three rather long oblique hinge teeth behind the beak, and of seven or eight shorter ones in front,—together with the cast of a deep, rather large, anterior muscular impression. The Chemung *A. acanthoptera* Hall, and *A. spinigera* Conrad, present much the general aspect of true *Aviculas*; but Prof. Winchell describes, from the Michigan rocks, a form which he refers to the first of these species, as having "a long posterior cartilage facet."

From all that is now known in relation to the affinities of these shells, we may safely infer that probably all of our Silurian and Devonian species, especially those of the Hamilton and Chemung groups, usually referred to *Avicula*, will be found to possess the internal characters of *Pterinia*, or of undescribed genera.

It is an interesting fact that the ancient *Pterinias* seem to bear the same relations to the existing *Aviculas*, or *Pterias*, that the

old *Aviculopectens* do to our modern *Pectens.*[*] For, in the modern types of the *Pectenidæ* and *Aviculidæ*, the cartilage is mainly or entirely confined to a pit or depression under or near the beaks, while, as already explained, in the Paleozoic *Pterinias* and *Aviculopectens*, we observe no such pit or depression, the cartilage being apparently attached by a series of linear furrows in a more or less wide, flattened, cardinal area, much as in the *Arcidæ.* This similarity in the arrangement of the cartilage of *Aviculopecten*, to what we see in *Pterinia*, *Myalina*, and some of the other groups here placed as a section of the family *Pteriidæ* (=*Aviculidæ*), together with the somewhat produced posterior ear of some of the *Aviculopectens*, would have led the writer to concur with Prof. McCoy, Mr. Woodward and others, in referring that genus also to the *Aviculidæ*, had it not been for the fact, that, on subjecting sections of a typical Carboniferous species (*Aviculopecten amplus* Meek & Worthen) to a microscopical examination, it was found not to possess the prismatic structure of the *Aviculidæ*, but the peculiar corrugated tabular structure of the *Pectenidæ*. From this fact, as well as the less oblique and more *Pectenoid* form of the *Aviculopectens*, we can scarcely doubt the propriety of including them, with probably several undescribed Paleozoic genera, as a section or subfamily of the *Pectenidæ*, parallel to the ancient *Pterinia* group in the *Aviculidæ*.

Amongst the genera here included provisionally in the group *Pteriniinæ*, the new name *Gryphorhynchus* will be observed. This is proposed for the reception of a group of small *Triassic* shells, of which *Avicula gryphæata* of Munster is the type, (see *Goldf. Petref. Germ.*, ii, p. 127, pl. cxvi, fig. 10, *a*, *b*, *c*, *d*, *e*, *f*, *g*). This genus may be briefly characterized as follows:—

Genus GRYPHORHYNCHUS, *Meek*.—Shell small, thick, nearly or quite as wide as long, very slightly oblique, plano-convex, or sub-hemispherical, the right valve being flat or concave, and the left very gibbous; posterior and anterior margins, somewhat sinuous, but neither valve with a defined byssal sinus. Beaks sub-central; that of the left valve elevated, gibbous, strongly incurved, and at the extremity directed obliquely forward; beak of right valve truncated so as not to be distinct from the cardinal margin. Hinge line equalling the greatest length of the shell, ranging more or less nearly at right angles to the umbonal axis; in both valves provided with a wide, well defined cardinal area. Ears subequal, not produced, concave in the right valve, and convex in the left, in which latter the anterior one is separated from the swell of the umbo by a deep oblique sulcus. Surface with fine, sometimes decussating striæ. Hinge with several small irregular teeth near the middle.

[*] The same relations are also observed between nearly or quite all of the Paleozoic *Nuculas*, so-called, and the true *Nuculas* of our modern seas.

This genus includes *G. gryphæatus* and *G. tenuistriatus* (=*Avicula gryphæata* and *A. tenuistriata*, of Munster, *Goldf. Petref. Germ.*, ii, 127–8).

In the same group may also be placed, as the type of a distinct subgenus, another little Triassic species described by Munster as *Avicula decussata* (*Goldf. Petref. Germ.* ii, 128, cxvi, 12 *a*, *b*). For this form I would propose the subgeneric name *Actinophorus.* It agrees with the typical species in all essential characters, excepting in being much more oblique, in having its posterior margin truncated at right angles to the hinge, instead of being slightly sinuous; and particularly in having the left valve ornamented with strongly elevated, distant, radiating costæ or plications.

I have not been able to see the prismatic structure in either of these types, but, from all analogy, I should suppose it could be detected in specimens in a better state of preservation. So far as known to the writer, this genus has not been discovered in America, and has only been found in the St. Cassian deposits of the Tyrol.

Under the *Aviculinæ* or *Pteriinæ*, it will also be observed that a new generic name, *Eumicrotis*, has been introduced. This is proposed for a well known type sometimes referred to *Avicula*, sometimes to *Pecten*, sometimes to *Monotis*, and by others to *Aucella.* Its type is *Monotis Hawni* Meek & Hayden, from the Permian rocks of Kansas. It also includes the closely allied European *Eumicrotis speluncaria*, (= *Gryphites speluncaria*, of Schlotheim, = *Monotis speluncaria* of King and others); also *E. radialis* (= *Pecten radialis* Phillips); and *E. Garforthensis*, (=*Monotis Garforthensis* King). This genus may be described as follows:—

Genus EUMICROTIS, *Meek.*—Shell more or less orbicular, plano-convex, the left valve being usually very convex, and the right flat or a little concave; not distinctly auriculate, the ears being nearly obsolete. Beaks subcentral, very slightly oblique, unequal, that of the left valve often elevated, gibbous and incurved; the other very small, and scarcely projecting above the hinge line. Hinge short, narrow edentulous. Byssal notch, or sinus of right valve, narrow, deep, sharply defined and separated from the hinge line by a small rudimentary ear, which does not project beyond the anterior margin of the valve. Scar of adductor muscle large and subcentral, those of the retractors small and placed near the beaks. Surface generally with radiating, vaulted, scaly costæ, much more strongly marked on the left than on the right valve.

The species of this genus have been usually referred to Bronn's genus *Monotis.* A careful comparison, however, of our Kansas specimens of the species described by the author in con-

nection with Dr. Hayden, under the name *Monotis Hawni*, with authentic European specimens of the type of Bronn's genus, (*Monotis salinarius*) now in the collection of the Smithsonian Institution, has satisfied me that they ought not to be placed in the same genus. In the first place, the type of *Monotis* is an obliquely oval, compressed, very nearly equivalve shell, with depressed, subequal beaks, presenting altogether a marked contrast with the general physiognomy of the shells belonging to the Permian and Carboniferous group under consideration. The most important difference, however, is the total absence of any traces of a byssal sinus in the anterior margin of either valve of the typical *Monotis*, the anterior margins of both valves being smooth, rounded, and without even the most obscure indication of an emargination, to represent the deep, sharply defined, byssal sinus of *Eumicrotis*.

I know nothing of the hinge, or of the microscopical structure, of *Monotis salinarius*, the specimens at the Smithsonian Institution being firmly imbedded in the very hard brittle matrix, and not in a condition to show any traces of minute structure. Dr. Carpenter, however, has examined a species—*Avicula cygnipes*, of Phillips—(which is unknown to the writer), supposed to be congeneric with the type of Bronn's genus, and finds it to possess the structure of the *Pectenidæ*, rather than that of the *Aviculidæ*. On examining thin sections of our Kansas shell, the type of the genus here described, by the aid of a magnifying power of about three hundred and fifty diameters, the prismatic structure of the *Aviculidæ* is distinctly visible.

Prof. McCoy was evidently much nearer right when he referred the European species of this group to Count Keyserling's Jurassic genus *Aucella*, than those who identified them with Bronn's genus *Monotis*. *Aucella*, however, although more nearly allied, was founded upon a distinct group of oblique, gibbous shells, all of which are destitute of radiating costæ or striæ, but ornamented with concentric undulations, giving them much the general appearance of some species of *Inoceramus*. They also have a small peculiar concave ear just in front of the beak of the left as well as of the right valve, formed by the inflection of the margin of the valve, unlike anything we see in the left valve of *Eumicrotis*. Count Keyserling's figures and description also show that the scar of the adductor muscle is placed much nearer the ventral margin in *Aucella* than in *Eumicrotis*. *Aucella* would therefore seem to bear similar relations to *Eumicrotis*, that *Posidonomya* does to *Monotis* proper, as typified by *M. salinarius*.

It is remarkable that, even in late European publications, we see the so-called *Monotis speluncaria* placed in the genus *Avicula*.

There is still another small group of Jurassic shells represented by one species in our collection from the far West, for which I

had thought a subgeneric name should be proposed. Farther comparisons, however, with specimens of some European species of this type, have led to the conclusion that these little shells form a section of the genus *Eumicrotis*, probably too closely connected by some intermediate forms to merit a distinct subgeneric name. The western species of this section alluded to above is *Avicula? curta* Hall, (*custa*, typ. err., *Stansbury's Report*, Expl. Great Salt Lake, 412, pl. ii, fig. 1, *a*, *b*.)[7] This section also includes the very closely allied European species *Monotis substriata* Munster: also *M. decussata*, and *M. Alberti* Munster, (*Goldf. Petref. Germ.*, ii, p. 138–9,) as well as a species figured by Goldfuss as *Monotis echinati*, (id., pl. cxxi, 6.)

These shells have much the general outline of the typical species of *Eumicrotis*, being short or suborbicular and but very slightly oblique, without any anterior ear, and generally having the posterior ear much abbreviated. They differ, however, in being smaller as well as more nearly equivalve shells, and in having the beak of the left valve much less prominent. Their valves are also destitute of an oblique sulcus often seen extending down the posterior side of the typical forms of *Eumicrotis*, and have a more regular appearance. They have generally a merely striated surface, and a very sharply defined byssal sinus near the beak of the right valve; in some of the species, however, the left valve has small radiating scaly ribs.

The structure of *E.* (*Avicula*) *curta* Hall sp., as seen by transmitted light under a high magnifying power, is finely prismatic.

In conclusion, I would remark that the numerous widely different types from the older rocks, figured in the various works on Paleontology under the names *Avicula*, *Pecten*, &c., show that much has yet to be done in classifying these shells, and that it will be necessary to establish a number of new genera for their proper distribution. I would also call the attention of paleontologists to the valuable assistance to be derived, at least in many cases, from microscopical examinations, in determining the family affinities of the ancient fossil genera of *Aviculidæ*, *Arcidæ* and *Pectenidæ;* especially, where the condition of the specimens under investigation is such as to prevent the nature of the hinge and interior from being determined. How far, however, the different types of structure may have been constant, amongst all the ancient genera of these families, remains to be determined by the examination of a larger number of species.

[7] The figures here referred to are not recognizable, but we know our shell to be the same, from comparing our specimens with the type of that species, collected at the same locality.

ART. XXI.—*On some Minerals of the Chlorite Group;* by JOHN B. PEARSE.

THE diversities of color among the varieties of the mineral species are in many cases still unexplained. A case of this kind occurs in the so-called kämmererite, from Lancaster county, Pa., of which there are three kinds—one colored pure green, a second red and green, while the third is of a pure red. The following investigation was undertaken to determine, if possible, the cause of this variation; and as the results have proved interesting, they have been further discussed in their general relations.

The mineral is in distinct crystals. There is the strongest evidence that all belong to the trimetric system, closely resembling many specimens of chlorite and some crystals of clinochlore. They are usually hexagonal in form, rising from their base as a truncated pyramid, but the lateral surfaces are so striated as to be incapable of measurement. The pyramid is made up of a pile of crystalline plates, with their slightly projecting edges manifestly replaced, indicating a dome and an octahedron.

The three varieties are well defined, the color of the first being a pure green, sometimes a rich emerald-green, while that of the second varies considerably between these two tints, being sometimes of a pure white; and that of the third is red, with an occasional tinge of reddish-white. In the second, the colors are confined to the laminæ, instead of mixing and giving a medium tinge. The third was also dichroic in the direction of the planes of its axes, being red in the direction of its shorter lateral axis, but of a violet-blue or hyacinth in that of the longer axis.

The hardness of the green and red is 2·75; the specific gravity of the green at 64° Fahr. 2·355, that of the red 2·383, which is perhaps a little too low, as it was impossible to free the crystals of a few minute bubbles of air. They consist of flexible micaceous plates, with a vitreous lustre, and white streak. Their blowpipe reactions show the presence of chrome, and silica, the absence of manganese in both, and the absence of fluorine in the green. Traces of the alkalies were shown in the red. Both the green and red are soluble in sulphuric acid with separation of silica, but are not acted on by chlorhydric acid. The purplish green not being obtained in sufficient quantity is not included in this description. This deficiency however proved unimportant, as the analysis showed its identity with the red.

Extreme care was taken in selecting the material for analysis. Fresh and perfect crystals were used for each analysis of the same variety, in order to certify undeniably the composition.

In no case was any crystal chosen the color of which was indistinct.

The following is an outline of the method of analysis adopted. After solution by means of carbonate of soda, and chlorhydric acid, the usual precautions being taken for an accurate estimation of the silica, the filtrate was rendered slightly alkaline with ammonia which precipitated the sequioxyds of iron, chrome and aluminum, with part of the nickel. This precipitate being dissolved was treated with acetate of soda, which separated the nickel oxyd from the sesquioxyds; the latter was then dried, weighed, pulverized carefully with carbonate of soda, and then fused together with nitrate of potash for chrome. This metal was estimated with the precautions detailed by Genth.[1] The residue being again dissolved, the iron was separated from the aluminum by caustic potash with the addition of sulphid of potassium. Great care was taken that the sesquioxyds of iron and aluminum were free from silica and perfectly washed. The nickel remaining in solution after the acetate separation was precipitated by sulphid of potassium. The filtrate from the ammonia precipitation, after the destruction of the ammonia by nitric acid, was treated by sulphid of potassium, as above, to separate the nickel from the lime and magnesia. The lime was precipitated as oxalate, and estimated as sulphate; the magnesia in the usual way. After the solution of the sulphid and the estimation of the oxyd of nickel, the oxyd was redissolved, and separated by ammonia from the impurities which cling to nickel so closely. The analyses, so described in outline, gave the following results—two determinatious being generally made of each constituent of the green and reddish-green.

	Green.			Reddish-green.			Red.
	No. 1.	No. 2.	Average.	No. 1.	No. 2.	Average.	
SiO_2*	28·800	28·444	28·622	31·515	32·200	31·857	31·315
Al_4O_3	18·375	....	18·375	13·746	....	13·746	12·840
Cr_4O_3	1·935	2·000	1·967	2·154	....	2·154	2·985
Fe_2O	3·862	3·606	3·734	2·307	....	2·307	2·457
Ni_2O	·370	....	·370	·231	·200	·215	·450
Ca_2O	1·590	1·303	1·446	1·273	....	1·273	·815
Mg_2O	31·766	32·483	32·125	34·871	34·929	34·901	35·020
H_2O	13·900	14·135	14·025	13·933	14·033	13·983	13·200
			100·664			100·436	99·082

* Si = 28·4, O = 16.

The joint weight of sesquioxyds in the green was 25·68 and 24·89; that of their separate determinations 24·32, the latter confirming the former, after exclusion of silica. These analyses show that the red and reddish-green are identical, but that they differ from the green. Since there is one per cent more of oxyd

[1] Chem. News, vol. vi, p. 32.

of chrome, and one and a third per cent less of protoxyd of iron in the red than in the green, the first question as to the cause of the difference of color is unanswered by analysis. It is possibly due to molecular arrangement.

The following formulæ exhibit the number of each class of ingredients, the sesquioxyds of chrome, iron, and aluminum being represented by Al_4O_3 and the protoxyds of magnesium, calcium, iron, and nickel, by Mg_2O, because aluminum and magnesium constitute by far the larger proportion of the bases.

Green, $5SiO_2+2Al_4O_3+9Mg_2O+8H_2O$.
Red, &c., $7SiO_2+2Al_4O_3+13Mg_2O+10H_2O$.

Without attempting at present to reconcile these numbers to any theory of the silicates, it will prove interesting to discuss the reliable results of analysis attained by different chemists, with different specimens of this and other minerals referable to the chlorite group. In order to show their mutual relations more clearly, I subjoin a table of their atomic composition, reducing them all to the proportions arising from two atoms of alumina.

Proportion of atoms in chloritic minerals.

	SiO_2	Al_4O_3	Mg_2O	H_2O	Analyst.
1. Kämmererite, crystallized,	5	2	8	8	Hermann.
2. My green, "	5	2	9	8	Pearse.
3. Chlorite (average analysis)	6	2	10	8	Rammelsberg.
4. Kämmererite, fibrous,	6	2	10	8	Hermann.
5. Chonikrite, massive,	7	2	10	6	von Kobell.
6. Rhodophyllite, crystallized,	7	2	12	10	Genth.
7. My red, "	7	2	13	10	Pearse.
8. Kämmererite, "	8	2	14	10	Smith & Brush.
9. Pyrosclerite,	8	2	12	10	von Kobell.
10. Tabergite,	9	2	14	10	Svanberg.
11. Kämmererite, crystalline,	9	2	11	10	Hartwall, Garrett.
12. Pyrosclerite, impure,	9	2	14	6	Lychnell.

A study of the above series of minerals by formulæ, and by their general agreement in external characters, establishes their relations and connection. I might have extended the list to embrace epichlorite, metachlorite, ripidolite, delessite, etc., but the above are sufficient for the discussion.

Genth's analysis of rhodophyllite (6) gives nine or ten atoms of water, and twelve atoms of magnesia; my red, and reddish-green (7) give ten atoms of water and rather less than thirteen atoms magnesia. I therefore prefer the formula I have given for Genth's rhodophyllite, with which my red is identical. Smith & Brush's kämmererite differs from rhodophyllite by an atom of olivine. These two formulæ may be regarded as reliable, being derived from well executed analyses of crystallized specimens.

We may reject at once from the above list chonikrite (5), and pyrosclerite (12) as impure. The kämmererite of Hartwall and Garrett (11) not being quite pure, and differing but slightly from von Kobell's pyrosclerite (9) might be referred to the latter, as Dana has done. But as pyrosclerite (9) differs by only one atom of silica from rhodophyllite, the latter in crystals, and the former of doubtful purity, pyrosclerite may be regarded as a less pure rhodophyllite. Svanberg's tabergite differs from Smith and Brush's kämmererite by only an atom of silica, and because the latter was in crystals, it is the true mineral, and the former an impure exhibition of it. I therefore refer the formulæ of 9, 10, and 11, to 6, 7 and 8, or 6 and 8.

It is noticeable that Hermann's kämmererite (4) is identical with chlorite, as determined by Rammelsberg's discussion of the latter's composition, but the former being fibrous, its purity may be doubted, and its formula set aside. The formula of chlorite is accepted as correct.

Comparing my green crystals (2) with Hermann's kämmererite (1) it is seen that they are manifestly identical; but as mine were carefully selected, perfect, transparent crystals, I give the preference to my own formula. Comparing my green with chlorite, it is clearly distinct; and I have therefore named it *Grastite*, (Greek γράστις, *grass*), from its green color.[3]

Our critical examination of the above series of minerals limits their number to four, viz. Nos. 2, 3, 6, (7) and 8, which are here presented as distinct varieties, together with the formulæ of olivine, augite, and serpentine, for the sake of further discussion.

Nos.		SiO_2	Al_4O_3	$\dot{M}g_2O$	H_2O	
2.	Grastite,	5	2	9	8	Pearse and Hermann.
3.	Chlorite,	6	2	10	8	Many analysts.
6.	Rhodophyllite,	7	2	12	10	Genth and Pearse.
8.	Kämmererite,	8	2	14	10	Smith & Brush.
	Augite,	1		1		
	Olivine,	1		2		
	Serpentine,	2		3	2	

A comparative study of the above shows the following remarkable differences between these varieties of the chlorite group:

Grastite + augite = chlorite.
Grastite + serpentine = rhodophyllite.
Grastite + olivine + serpentine = kämmererite.

In other words, the differences of composition between members of the chlorite group are the simpler minerals associated with them in locality, or from which they have been heretofore assumed to be derived.

[3] My apology for a new name is that not one of those heretofore proposed for any member of this group is applicable.

If I may be allowed to hazard a conjecture as to the introduc-
ɔn of alumina to those simple minerals to build up the chlorite
'oup, I suggest that it is due to the conjoined influence of adja-
nt decomposed feldspar, and a solution of magnesia. For de-
mposed feldspar, I take the most general composition of kaolin,
ıd for solution of magnesia, brucite. Grastite and kämmer-
ite may be supposed to be formed thus:

	SiO_2	Al_4O_3	Mg_2O	H_2O
Grastite:				
1 atom of kaolin,	3	2		3
2 " " olivine,	2		4	
5 " " brucite,			5	5
1 " " grastite,	5	2	9	8
Kämmererite:				
1 atom of kaolin,	3	2		3
3 " " olivine,	3		6	
1 " " serpentine,	2		4	2
5 " " brucite,			5	5
1 " " kämmererite,	8	2	14	10

A moment's consideration will show that these conjectures are
ɔt unfounded. Chlorite is found where talcose matter and feld-
ɔar are associated or near together, and is supposed to arise
om augite. The others are found in or near serpentine with
ljacent feldspar, and serpentine has been supposed to be de-
ved from olivine. The locality in which grastite, rhodophyl-
te, and kämmererite are remarkably developed, viz. Lancaster
ɔunty, Penn., abounds in brucite. In fact brucite either as such
r altered into serpentine, is a common constituent of serpentine
ɔck. Thus the marmolite of Hoboken, and of other localities,
pure serpentine, exhibits all the crystalline peculiarities of
rucite. A similarly altered brucite from Siberia, in the collec-
on of J. A. Clay, Esq., of Philadelphia, has the precise hex-
gonal forms of the fine crystals of brucite from Lancaster Co.,
'enn. We have therefore only hazarded a natural conclusion,
ıat chloritic minerals are formed from their simpler mineral
ssociates.

Philadelphia, Oct. 26th, 1863.

ART. XXII.—*Notice of a small collection of Fossils from the Potsdam Sandstone of Wisconsin and the Lake Superior Sandstone of Michigan;* by Prof. ALEXANDER WINCHELL.

THE University of Michigan is in possession of a small collection of fossils from the Potsdam Sandstone of Sauk county, Wisconsin, contributed by one of the *alumni*, Joseph W. Wood. The interest which attaches to every vestige of organic life belonging to this age induces me to offer a few words in reference to the new data in my possession.[1]

Mr. Wood, in transmitting the specimens, writes: * * * "They are found overlying, and in connection with, the "quartzite" of the Devil Lake[2] and Baraboo Bluffs. * * * The quartzite is an indurated sandstone containing ripple marks in abundance—also conglomerates, and, in places, thin layers of talcose slate. It has been upheaved along an east and west axis, * * * the main ridge pushing the Wisconsin river to the east, where it almost forms a junction with the Fox, and at which point the two are joined by a canal. There are many minor ridges, running both parallel and crosswise." About three miles south of the village of Baraboo, the main ridge has been broken open, forming an *anticlinal* valley, in which rests Devil Lake—the semi-stratified quartzite dipping rapidly toward the north-northeast on the east side, and rapidly toward the northwest on the west side, and forming bluffs 450 and 500 feet high on the two sides respectively. The longer axis of the lake is transverse to the main axis of the ridge. South of the bluff, on the east side, and beginning opposite the southern portion of the lake, is a low, level valley, which extends eastward to the Wisconsin river. South of the valley, and bounding the lake at its southern extremity, is a low bluff presenting nearly horizontal stratification; but probably dipping gently southward, since, in the region three or four miles farther south, it supports the first outliers of the Calciferous sandrock.

The high bluffs surrounding the lake are described by Mr. Wood (and also by Prof. Hall in the Wisconsin Report) as consisting entirely of bluish or iron-stained quartzite, exhibiting a

[1] The present paper was written and accepted for publication in this Journal before I had become aware of the existence of the very important paper recently issued by Prof. Hall on the Potsdam sandstone of the Northwest. Of the patience and research whose results are set forth in this exhaustive monograph, I here express my great admiration. It will nevertheless be observed that Prof. Hall's monograph does not embrace a notice of any fossils found as far south as those which form the subject of this paper; and I feel that some interest must still attach to the descriptions which are here presented. It will appear evident that a few features have been added to the present paper since the appearance of Prof. Hall's monograph. Other recent information from Mr. Wood has also been incorporated.

[2] Sometimes improperly styled "Spirit Lake."

gradual passage into an overlying conglomerate, which, in turn, assumes, above, the characteristics of the Potsdam sandstone. Both insist on the absolute continuity and conformability of the quartzite, conglomerate and sandstone. Mr. Wood says: "It is in the northern slope of the main ridge (on the east of the lake) that I found these fossils. If the sandstone containing them shall be called 'Potsdam,' and the main ridge 'Quartzite,' then I should say that they were a continuous deposit; and I do not know of any reason for separating them, only that they differ in hardness; while it is only at the extremes of the scale that this difference is manifest." Prof. Hall states (*Geol. Rep. Wis.* 1862, pp. 11 and 12) that the quartzite is terminated upward by a conglomerate which graduates into the Potsdam sandstone; and agrees with Mr. Wood, that "in some cases the passage from the conglomerate to the sandstone is so gradual that it is impossible to point out a line of demarcation. In the lower part," Prof. Hall further says, "the conglomerate is so destitute of any other materials than the sand and pebbles of the quartzite below, that it bears little affinity to the sandstone above." Nevertheless, Prof. Hall is of the opinion that "the quartzite holds the same relative position to the Potsdam sandstone as the Huronian system of the Canada survey."

Some of the fossiliferous fragments forwarded by Mr. Wood contain pebbles three-fourths of an inch in diameter; and I should infer from this circumstance, as well as the position of the fossils upon the northeastern flanks of the bluffs, that the remains under consideration occupied a place near the boundary line between the conglomerate and the recognized Potsdam sandstone.

I insist particularly upon the stratigraphical position of these fossils, because they show, contrary to the conclusions of Prof. Hall's monograph, that *Dicellocephalus* and *Ptychaspis* occur at the recognized base of the Potsdam sandstone, as well as above. The alternative of this conclusion is an admission that *the conglomerate and quartzite are truly (as they appear to be) the downward continuation of the Potsdam sandstone*, and the prolongation of beds which, further north, exhibit a more typical character. If, as I infer from Mr. Wood's communications, the mass of quartzite is superimposed, a little farther south, by the outliers of the Calciferous sandrock, this fact would give countenance to the alternative suggested.

Scolithus linearis.

S. linearis Hall, is present in abundance in some of the fragments, in the form of straight, cylindrical, nest-like cavities, two or three inches long, extending vertically to the planes of bedding. They vary from ·05 to ·27 of an inch in diameter.

ORTHIS BARABUENSIS, n. sp.

There are several imperfect specimens of an *Orthis*, apparently of the type of *O. biforatus*. The form is transverse, with a straight hinge-line, and the sub-equal beaks a little elevated above it. Greatest width of shell along the hinge, in front of which the sides are considerably constricted, and continue to approach each other, though less rapidly, to the somewhat straight anterior margin. Ventral valve with a sinus of moderate depth, which is rather broad, and near flat at bottom. Surface with sixteen or eighteen ribs visible on the cast, the strongest of which limit the mesial sinus, which has in the middle a barely visible costal ridge. The interior of this valve exhibits a pair of rudimentary hinge teeth, separated by a triangular foramen. The interior myary scars occupy only a small space near the beak, and present an elliptical outline. The dorsal valve is equally convex with the ventral, and exhibits a broad, depressed mesial fold.

Length of hinge-line ·76 (100); length of shell from beak to anterior margin ·38 (50).

Dr. D. D. Owen (*Rep. Wis. Io. and Min.*, p. 575) and Shumard (*St. Louis Trans.*, i, 627) have made allusion to the existence of this genus in the Potsdam sandstone of the northwest; and a species has just been described by Prof. Hall under the name of *O. Pepina.* Our specimens from Baraboo differ from both this and *O. Coloradoënsis* Shum., in its more transverse shape, fewer ribs and want of concentric lines.

STRAPAROLLUS (OPHILETA) PRIMORDIALIS, n. sp.

A planorboid shell, three-fourths of an inch in diameter, and having the apex of the spire depressed below the level of the outer whorl. The number of whorls is probably about five, but only the last two are preserved in the best specimens. The tube enlarges very gradually, and is marked by a distinct carina just above the peripheral line, above and below which is a shallow groove.

Some of the specimens of this fossil greatly resemble the figure of *Ophileta complanata* Vanuxem, from the Calciferous sand-rock of New York; but the volutions enlarge a little more rapidly, and present a distinguishing angulation. No allied species has been described from the Potsdam sandstone (unless it be *O. compacta* Billings, a description of which I have not seen). The *Euomphalus? vaticinus* Hall (*16th Rep. N. Y. Regents*, p. 136) is described and figured as "gently convex above."

PLEUROTOMARIA? ADVENA, n. sp.

A trochoid or sub-turreted shell, of at least four whorls, which are depressed-convex externally, and apparently destitute

of all superficial ornaments. But three whorls have been seen; these are ·66 inch in height, and the lower one is about ·77 inch in diameter—the three being of nearly equal height.

This fossil is quite unlike anything described from the Potsdam sandstone; and there is nothing in the Calciferous sand-rock which approaches nearer than *Holopea Proserpina* Billings (Pamphlet, Jan. 1862, p. 28), with which this may be congeneric.

DICELLOCEPHALUS MINNESOTENSIS, Owen.

Several specimens occur in the collection which I feel obliged to refer to this species. Some well preserved pygidia do not disagree with Owen's and Hall's (*Foster and Whitney's Rep. on L. Sup. Land Dist.*, pl. xxiii, fig. 30) figures, except that Hall's specimen had lost its caudal flap—a feature well preserved in my specimens, and distinctly reflected upward. Nevertheless, no caudal spines are preserved in any case; and the condition of the specimens would indicate that they were wanting. An imperfect cephalic shield presents a flat border, about as wide as the caudal flap, and, like it, turned slightly upward, and is destitute of a thickened margin. The glabella is truncately rounded in front; the two sides are nearly straight, but not perfectly parallel—being approximated anteriorly at an angle of about 12°. There is at least one furrow extending across the glabella; and in front of this, opposite the anterior extremity of the palpebral lobes, another furrow on each side, reaching less than one-third the distance transversely across the glabella. The course of the great suture in its anterior extension conforms to the requirements of this species.

A doubt may exist whether these specimens are correctly referred, in consequence of the absence of the caudal spines and the defective condition of the posterior portion of the cephalic shield. It seems to me, however, that a pair of blunt spines, in an attenuated peripheral part like the caudal flap, cannot form an indispensable diagnostic character. The direction of the facial suture is exactly that of *D. Minnesotensis;* and the inclination of the sides of the glabella, even if slightly greater than is usual for this species, is not as great as in *D. misa* Hall. The pygidium conforms, in its want of spines, to that of *D. misa*, but the configuration of the glabella and the anterior lobe of the fixed cheek deviate decisively from that species.

DICELLOCEPHALUS PEPINENSIS, Owen.

An imperfect cephalic shield shows a narrow border, with a decidedly thickened margin, which is broader than the furrow between it and the front of the glabella. The glabella is prominent, with sub-parallel sides and an obtusely rounded anterior extremity. Opposite the middle of the prominent palpebral

lobes, a furrow passes quite across the glabella, being curved backward in the middle. Behind this is another nearly parallel furrow, and in front is a pair of faint furrows situated nearly opposite the anterior extremity of the palpebral lobe, and each traceable about one-third the distance across the glabella. Another glabella, very similar to this, shows three transverse furrows, besides the anterior interrupted furrow.

A finely preserved pygidium presents a strong convexity, especially in the middle lobe. Aside from the marginal flap, the external outline is nearly semicircular, with the anterior margin considerably curved. The lateral lobes are strongly convex, becoming less so nearer the border, and abruptly joining the caudal flap, at an inclination of about 45°. The pleuræ are furrowed in such a manner that there seems to be an accessory pleura between each two principal ones. The articulations are seven in number in both the axial and side lobes, and extend nearly to the terminal apex of the middle lobe. The caudal flap is flat, and about as wide as the middle lobe at its anterior end, and marked uniformly through its whole length by eight or more rigid concentric striæ. No indications of caudal spines.

This pygidium was originally referred to this species on such information as was accessible, amongst which was Hall's figure in the Wisconsin Report (p. 22, fig. 4), showing indications of a similar striated caudal flap. I am not able by the help of Prof. Hall's last memoir to change the reference, although I perceive the pygidium does not fully agree with the complete characters now published. I am inclined to think this pygidium has not previously been described.

PTYCHASPIS BARABUENSIS, n. sp.

The collection embraces some fragments of the cephalic and caudal shields of a large trilobite, which, while its generic relations are somewhat indeterminate, has a certain expression which is peculiar. The head is about 2·4 inches broad, and rather convex; the thickened and convex margin of the border is separated from the glabella by a narrow, concave furrow, giving the border a width of three-tenths of an inch. Posteriorly, the border is continued in genal points which attain a length not less than three times the length of the glabella. The movable cheek is swollen and separated by a deep transverse furrow from the posterior borders of the cheek. The surface is feebly scrobiculate-wrinkled; though with oblique light it is seen to be distinctly so, and the character is even better shown with a low magnifier, though the cast is preserved in sandstone.

The pygidium which undoubtedly belongs to the same species is 2·9 inches across, and three-fourths of an inch in height. The middle lobe is nine-tenths of an inch across, and is quite

prominent, with its posterior portion inarticulate and broadly rounded. There is no limiting furrow separating it from the lateral lobes; and posteriorly it fades insensibly into the terminal border. The lateral lobes are but faintly articulate, and, meeting behind the axis, form a border three-fourths of an inch broad, which is strongly curved downward on all sides, and presents a circularly curved outline, without any indications of caudal appendages.

The foregoing was written before seeing Prof. Hall's memoir; and I had referred the specimens to *Dicellocephalus*, with a query. I could scarcely doubt of their generic distinctness, but felt reluctant to engage in genus-making without ampler materials. I am happy now to recognize Prof. Hall's new genus as exactly meeting my want. This species differs from *P. Miniscaënsis* Hall, in its broader and fuller movable cheek and broader margin, and much longer genal points.

II. The University has for many years been in possession of some fucoidal remains from the red sandstone of the south shore of Lake Superior. As it is so uncertain when any further paleontological data will be obtained from that region, I do not deem it necessary to defer longer a brief notice of these fossil Algæ.

There are two methods of frond-arrangement noticeable among these remains. One exhibits a rudimentary symmetry, while the other is totally destitute of it. There is little difficulty in deciding that neither form falls under any description that has been published; but it is nearly or quite impossible to determine whether these differences are of generic, specific, or still inferior value. The great variation exhibited in the arrangement of the different portions of the fronds of recent marine algæ, shows how little dependence can be placed upon descriptions founded on detached fragments of these fossil fucoids. Those differences which have been sometimes recognized as marking the bounds between distinct genera, may easily have co-existed upon the same frond. There was great plausibility in the method pursued by the older writers in referring all these remains to the single genus *Fucoïdes*.

There seems, nevertheless, some prospect of utility in making such distinctions as we are able; and while I cannot vouch for the generic characters of the fossils under consideration, I shall refer them provisionally to a Paleozoic genus established by Prof. Hall to receive some fucoids from the Calciferous sand-rock of New York.

PALÆOPHYCUS ARTICULATUS, n. sp.

Consisting of large, straight or geniculated, compressed-cylindrical, irregularly articulated, branching stems. The largest

stems are an inch and a quarter in diameter; the transverse section oblong, rounded at the ends, or, in other cases, more nearly a circle. The branches are uniformly much smaller than the main stem, and leave it at an angle of about 30°. One of the most marked peculiarities of the species is the somewhat regular transverse constrictions, which occur at intervals of about half an inch, in most of the specimens. At these constrictions the fucoid has shown a disposition to separate, so that most of the fragments present sharply truncate extremities. Surface smooth.

This fucoid is found abundantly scattered over the surfaces of slabs of dark red, fine-grained sandstone, from the north flank of the Porcupine mountains, Lake Superior.

Collected by Dr. Douglass Houghton, in 1840.

PALÆOPHYCUS INFORMIS, n. sp.

Fucoid apparently consisting of fleshy, leaf-like masses, having an irregularly triangular, elongate, or variously amorphous outline. In some instances it would seem that a hollow, conical piece had been compressed so as to present two opposite edges. Sometimes an irregularly elongate piece presents occasional enlargements and tuberculous eminences. There are some indications that the plant was branched, some of which consist in the close approximation of co-adapted edges without complete junction. The surfaces are smooth and shining. The fragments vary from half an inch to two inches in width.

Abundant in dark red sandstone from Montreal river, Lake Superior—a region where Col. Whittlesey estimates the formation to attain the enormous thickness of 15,000 feet. (*Proc. Bost. Soc. Nat. Hist.*, ix, July, 1863.)

Collected by Dr. Houghton, in 1840.

Similar but thinner and more ill defined fucoids occur in red sandstone three miles west of Eagle river; and again in white sandstone near Carp river, on the south shore of Lake Superior.

In associating these remains with others from the Potsdam sandstone of Wisconsin, I do not intend to express any opinion whether the Lake Superior sandstone is of Mesozoic age, as argued by Jackson and Marcou; or of the age of the Chazy formation, as recently concluded by the Canadian geologists (at least in reference to the St. Mary's sandstone); or the prolongation of the lowest fossiliferous sandstones of Wisconsin, as thought by Messrs. Foster and Whitney, and formerly by Hall, and still earlier intimated in the unpublished notes of Dr. Houghton; or finally, as now intimated by Hall, a formation ranging from a horizon below the fossiliferous sandstones of Wisconsin to the top of the Chazy formation or St. Peter's sandstone.

University of Michigan, Dec. 11th, 1863.

ART. XXIII.—*On the Orbits of Binary Stars;* by Prof. DANIEL KIRKWOOD, Bloomington, Indiana.

THE whole number of double stars hitherto observed is rather more than 6000.[1] The proportion of these in which the duplicity is merely optical cannot now be determined: the number, however, in which a change of relative position had been detected, was, at the middle of the present century no less than 650. In the motions of these bodies, so far as observed, we find one general and striking characteristic; *the orbits are much more elliptical than those of our planetary system.* In Sir John Herschel's Table (1850) of fourteen double stars whose orbits had been calculated, the eccentricity in seven cases is greater than that of Faye's comet (0·5559); while in the case of *Alpha Centauri* it is nearly equal to that of Halley's.[2] We propose to inquire whether this remarkable fact in regard to the sidereal orbits is susceptible of explanation by the nebular hypothesis.

In a former number of this Journal[3] it was stated that the theory of Laplace, which so beautifully accounts for so many otherwise unexplained phenomena of the solar system, might be extended to the binary and multiple systems among the so-called fixed stars. But how, it may be asked, can the same theory explain the almost *circular* orbits of the planets and also the extremely *elliptic* motions of the sidereal systems?

The correllation between the members of a binary system is different from that between the sun and a planet. In the former, both are large, self-luminous bodies; on the other hand, our solar system has resulted from the concentration of the whole mass of a primitive nebula about a single nucleus. Now if a mass of nebulous matter, in which the process of condensation has commenced, have a very slow rotation, and if, instead of a *single* center of attraction, *two* distinct nuclei be formed, the consequence may be its complete separation into two bodies while the rotation is yet so slow that the centrifugal force as compared with the centripetal is too feeble to produce a nearly circular motion. While, therefore, orbits of small eccentricity must characterize planets formed from the abandoned equatorial rings of a condensing nebula, orbits highly elliptical may be regarded as the probable consequence of a separation in the earlier stages of its physical history.

[1] The components being less than 32″ asunder.
[2] The eccentricity of the former is 0·95; that of the latter, 0·9674.
[3] For September, 1860, p. 165.

ART. XXIV.—*On the best Mode of presenting, in a popular form, the Theory of the Tides, with suggestions for constructing illustrative apparatus;* by WILLIAM DENNIS, Philadelphia, Pa.

IT is remarked by Sir J. Herschel that "many persons find a strange difficulty in conceiving how they (the tides) are produced;" and Mrs. Somerville goes so far as to say (*Physical Sciences*, C. 13), that among those classed as astronomical problems this "is by far the most difficult and its explanation the least satisfactory." This latter statement is perhaps rather broad as it stands, but if it were limited somewhat, so that the singularity of the phenomenon and the importance and familiar interest that attach to it and to its effects should be taken into account, it would scarcely require further qualification. It can hardly be denied that an intelligent comprehension of this subject is rare even among those to whom the causes of most natural phenomena are familiar, while to the great majority of intelligent people it is altogether a mystery. It seems, therefore, worth while to enquire whether the difficulties complained of have been reduced to a minimum, or whether they be not in part owing to defects or errors in the usual mode of presenting the explanation.

Having had occasion, in the preparation of a new elementary treatise on astronomy, to consider this subject attentively, as well as to examine the explanations commonly given, I have been compelled to conclude that no small portion of the obscurity and perplexity commonly supposed to belong to this subject arises from the want of a proper consideration and statement of the conditions and circumstances under which the causes producing the phenomenon act. If a learner be told, (and for whom are explanations intended if not for learners?) that the waters of the ocean are raised by the moon's attraction, his first idea, in many cases, will be that they are lifted up *by main strength*, as it were, the force of gravity being *overcome*,[1] and having no where observed any similar effect of the moon's attraction, he cannot conceive how this can be. Nor will it tend in any degree to lessen his perplexity if he shall see it stated, (as he may,) that according to Newton's calculations, the *disturbing* power of the moon's attraction on the surface of the earth is less than a ten-millionth part of the force of gravity, and that of the sun's attraction not even half as great as it. It is therefore important to show, by a preliminary explanation, that the waters of the

[1] An idea akin to this must exist, it would seem, in the minds of those authors who speak of the *lateral* attraction of the moon at a given place after or before its passing the meridian of that place; as if this *disturbing* force, so minute at its greatest, and in respect of this lateral action, so greatly reduced by its very oblique direction, or else by the near approach of the place in question to the *mean distance* could ever produce any appreciable effect whatever in that way.

ocean, in their general figure and outline, are in a state of perfect equilibrium or perfectly balanced, so that, in view of this, and of their vast extent and perfect freedom of motion, they may be compared to a scale-beam in perfect equipoise, suspended in the most delicate manner, and *several thousand miles in length.* To omit this would be much the same as if one should state, in proof and illustration of the attraction of gravitation, that a weight or ball at the side of a mountain had been observed, (referring to the Schehallien experiment,) to be drawn towards the mountain by its attraction, leaving the learner to suppose that the weight was placed on a table or other level surface instead of being suspended by a long thread or wire.

In explaining this condition of equilibrium the most obvious course will be to refer to mere hydrostatic equilibrium, in which any portion of these waters may be regarded as exactly balanced by any other contiguous portion, each being maintained at its level by the pressure of the other which supports it: consequently if this pressure be, in the case of either portion, lessened or increased *in the least degree*, that is to say, if the force of gravity, to which this pressure is due, be in any degree counteracted or added to by any other force in one of these portions and not in the other; the lighter portion will immediately give way and be buoyed up by the heavier which will of course simultaneously sink: and this would be an explanation sufficient for the purpose. But as this statement, though true, is not the whole truth, it may be well to go a step further. The waters of the ocean do not maintain their general figure and outline under the influence of gravity alone. On the contrary it is well known that by the centrifugal force generated by the earth's rotation on its axis they are kept at a higher level or greater distance from the centre on other parts of the globe than at the poles, this elevation amounting at the equator where it is greatest to about 13 miles. They are therefore exactly suspended or poised between these two forces, namely, the force of gravity and the centrifugal force just mentioned, and any other force that should in the least degree add to or counteract the influence of either of these forces would at once cause a change in the figure of these waters. While therefore it is properly the hydrostatic equilibrium existing between the different portions of the waters themselves that is disturbed by the action of the forces that produce the tides, the statement just made may serve to show more clearly how far these waters are, in their normal condition, from lying as a *dead weight* in the depressions of the earth's surface that contain them.

Again it is stated in a familiar way, (see *Chambers Hand-B. of Astron.*, *Bouvier's Famil. Astron.*, et al.,) that the tide on the side of the earth towards the moon is owing to the waters there being attracted by it more than the mass of the earth because they are

nearer, while the tide raised at the same time on the opposite side of the earth results from the earth being drawn away from the waters there because they are more remote than the mass of the earth and are thus "left behind," or "left heaped up;" and then we are told that at full moon, when the attractions of the sun and moon are *opposite* in direction, they conspire to produce spring tides in the same manner as at new moon when their attractions coincide in direction. Now as it is not easy to see how a body can be drawn away so as to leave any thing behind in two opposite directions at the same time, these statements appear quite inconsistent and are well calculated to confuse and perplex. It is therefore important and indeed indispensable to the communication of an intelligible view of this phenomenon to explain, as before remarked, the conditions and circumstances, or, to express it more definitely, the relations and dependencies existing among the bodies concerned in it: a course at once so natural and so needful that it seems remarkable that it should not have been more generally and more fully adopted.

As the earth is *held* to its curved path around the sun by the attraction of that body acting in opposition to the centrifugal force generated by its rapid motion, in the same manner that a heavy ball or weight attached to the end of a cord and whirled around the head is held or restrained by the cord, we may regard it as suspended between these two forces, and if a ball be merely suspended by a cord it will be a fair illustration of its condition; the force of gravity or weight of the ball standing in place of the centrifugal force in the case of the earth, and the tension of the cord representing the restraining force of the sun's attraction which at each instant holds the earth to the place in its orbit which it occupies. But as this attraction of the sun diminishes rapidly with an increase of distance it is plain that it cannot hold *all parts* of the earth alike or equally, the nearest part being about 8,000 miles less distant than the most remote, while of course it holds *the whole as a mass* as it would hold it were it at the *mean* distance of all the parts, that is, at the distance of the centre. Consequently on the nearest part or side towards the sun the attractive force being greater than the mean, there will be a small *excess* over what is sufficient to hold *this part* to its place in the orbit, and this excess acting upon the surface waters there in opposition to the force of gravity renders them specifically lighter and the exact equilibrium before described is immediately disturbed: these waters will therefore rise somewhat while those that are so situated as to be unaffected by this disturbing influence will sink simply from the *giving way* of those which having become lighter yield to their superior pressure. Again on the opposite side of the earth or that most remote from the sun, the attractive or restraining force will be less

than the mean and therefore not quite equal to the centrifugal force and here accordingly there will be an excess of this latter force: but on this side it is this centrifugal force that acts in a direction opposite to that of gravity, and this *excess* of it will consequently disturb the equilibrium of the surface waters here in precisely the same manner as in the other case.

Referring now, for illustration, to the suspended ball before mentioned, let us suppose it to be a hollow globe one or two feet in diameter, of a quite flexible material, as India rubber, having an opening about half an inch in diameter at the top and also at the bottom: let the principal suspending cord pass through the top so as to be attached at the centre to the intersection of two stiff horizontal wires, which are placed at right angles to each other and the extremities of which pass *loosely* through small openings in the sides of the globe. Passing this cord over a pulley and attaching a weight, so adjust the weight that it shall be sufficient to support the *middle* horizontal zone or segment of the globe. Let there be two other cords with pulleys and attach one to the top of the globe and the other to the bottom, the latter passing down through the opening in the top; then attach to the former a weight *somewhat more than* sufficient to support the top part of the flexible globe and to the latter a weight *not quite* sufficient to support the bottom part. Now it should be remembered that in this illustration the force of gravity or weight of the globe stands in place of the centrifugal force generated by the earth's motion in its orbit, and the tension of the cords, in place of the sun's attractive force varying at different distances: the cord attached to the wires at the centre may then represent the mean attractive force of the sun at the mean distance, as by this the globe is mainly held to its place, while the greater of the other two weights, being a little more than sufficient to support the part upon which it acts, will represent the attractive force acting upon the part of the earth nearest the sun, and the smaller weight, not quite sufficient for the same purpose, will represent the attractive force acting upon the opposite or most remote side. The globe being flexible, it is evident that the top part will be drawn up somewhat by the *excess* of the weight connected with it, while the bottom part will sink from the *deficiency* of its counterpoise and the whole will be elongated vertically and *for that reason* contracted horizontally. In like manner is the earth, in its yielding portions, the waters, elongated in one direction, that is, in the direction of the attracting or restraining force of the sun, and for that reason contracted in the direction at right angles to that.

Such is a statement of the general principle upon which the attraction of the sun (or of the moon) tends to produce a tidal

elevation on two opposite sides of the earth with intermediate depressions; and I prefer taking the case of the sun for this statement because the relations upon which this phenomenon depends are in general better understood or at least are more familiar to most as they exist between the earth and the sun than the same sort of relations between the earth and the moon.

Indeed, the sun being the great central power which controls the general motions of both the earth and the moon, there seems to be a manifest propriety in commencing with its influence, and, for the same reason, it will doubtless seem to many at first sight that it should be the chief and controlling cause of the tides. But this is not the case. The disturbing influence of the attracting body depends, not on the difference simply between the distance of the centre of the earth from it and that of the nearest or most remote side, but on this difference as *compared with the whole distance.* Now this difference in the case of the moon is about one-sixtieth part of the whole distance, but in the case of the sun it is less than a twenty-thousandth part, and hence it happens that while the attractive force of the moon is quite small compared with that of the sun, its *disturbing influence* is about two and one-half times that of the larger body.

Accordingly it is found that the moon exercises a *controlling* power over the tides, and the influence of the sun appears only in *modifying* the effects which it produces. We have now therefore to consider the case of the earth and the moon and to apply to it the principle already explained.

If it were a tide upon the moon that we are to explain, the complete analogy between this case and that of the earth and the sun would be at once recognized, the revolution of the moon around the earth being a fact as familiar to most as that of the earth around the sun. But action and reaction being always equal, while the earth *holds* the moon to its course or orbit in opposition to the centrifugal force, the earth itself is in like manner attracted and held by the moon to an extent proportioned to its inferior size or mass, and the consequence is that both bodies revolve about their common centre of gravity, that is, about a point between them which is as much farther from the centre of the moon than it is from the centre of the earth as the earth is heavier than the moon. That this point is comparatively near the centre of the earth, even nearer than (or within) the surface, in no way affects the operation of the causes which produce the phenomenon under consideration; but it is important to guard against what seems to be a very common misconception of the revolution of the earth about this point. This material error consists in supposing that point in the earth where this centre lies, or which coincides with this centre at any instant, to be *stationary* as regards this revolution, while the other parts of the

earth revolve about it; whereas, it is a revolution of the centre of the earth around this common centre of gravity, every point in the surface or elsewhere having a *corresponding motion:* it is not a revolution of the *parts* of the earth about a point within it which remains fixed, but a revolution of the earth *as a mass* about a certain point lying between its centre and that of the moon. This being understood, the case of the earth and the moon may be regarded as precisely analogous to that of the sun and the earth as already explained: in performing its revolution in this narrow orbit, (its diameter is about 5,400 miles,) the earth is held to a curvilinear motion in opposition to the centrifugal force by the moon's attraction, in the same manner that it is held to its larger orbit by the sun's, and there is consequently a corresponding *excess* of the attractive force over the mean and therefore over the centrifugal force on the side of the earth towards the moon, and a corresponding *deficiency* of attraction and consequent excess of centrifugal force on the opposite side. Hence, there must result, as in the former case, a disturbance of the equilibrium of the surface waters—a tendency in those on these two sides to rise to a higher level, and a consequent depression of those portions not affected by this disturbing influence. The illustrative apparatus, described in reference to the sun's action, is evidently equally applicable to this case. If it be thought desirable to render the representation more exact by exhibiting a *greater* effect than that produced for the case of the sun, it will only be necessary to increase the difference between the weight attached to the top and that connected with the bottom by reducing the latter and adding to the former.

It has been already stated that, in consequence of the comparative nearness of the moon to the earth, its attraction is the chief and *controlling* cause of the tides, but the sun, although its distance is 400 times as great, has yet sufficient influence to modify materially the effects which the smaller body tends to produce: it remains to show how these two causes operate in combination, or, in other words, how the effect produced by the moon as principal is modified by the action of the sun as accessory. Taking, first, the case of the two bodies being in conjunction at new moon, it is easy to see that, as they are both on the same side of the earth, their attractions have the same general direction and must therefore conspire to produce the same effect which will of course be an exaggerated one: hence the spring tides that are observed about the time of new moon. Nor is what has been already stated in relation to the earth's being held to its place by the sun's attraction in any way inconsistent with this result. It is still held by the sun, and with the same force, but the attraction of the moon is *added* to that of the sun and it is thus not merely *held*, but actually drawn out of the course which it would

have taken under the influence of the sun's attraction alone and brought for the time somewhat nearer to the sun.

Again, when the two attracting bodies are on opposite sides of the earth at full moon, it will be found that the result should be the same; for the earth is still held, and its two opposite sides *unequally* held, by the sun's attraction, which thus produces an elongation, or a tendency to elongation, in the manner before described: at the same time it is drawn, and these two sides unequally drawn, in the opposite direction by the moon's attraction; and as the side that is held least firmly by the sun is the one most attracted by the moon, and *vice versa*, this action of the moon will also tend to produce a further elongation in the same direction. Hence, these separate actions combine and produce an increased result, which appears in the spring tides belonging to the full moon. Nor can the separate *influences* of the sun and moon, (as it is important to note,) in any degree counteract or interfere with each other. Their *effects* may be combined, opposed, or mutually modified, according to the circumstances of each particular case, but the tendency of each of these attracting bodies, so far as the phenomenon under consideration is concerned, is to produce its own specific effect, and this *tendency* is in no way materially affected by the position or action of the other at the same time. To be satisfied of this, we have only to observe that the earth is at all times and under all circumstances held suspended by the sun's attraction without regard to the moon's position or action upon it. While thus held or suspended, the moon by its attraction draws it somewhat out of the course it would otherwise pursue, bringing it now a little nearer to the sun and then taking it a little farther from it, at one time hurrying it onward and again retarding it somewhat, (movements necessarily resulting from that revolution of the earth about the common centre of gravity of itself and the moon before explained); but this *by-play* between the earth and the moon in no way essentially affects the relation existing between the earth and the sun: the former unceasingly pursues its orbital course around the latter, which must therefore constantly hold it suspended by its attraction as already described.

The case in which the sun's and moon's attractions being in the same direction (at new moon) conspire to produce a greater effect, namely, the spring tides of new moon, seems hardly to require separate illustration. It is as if the power of one of these bodies were temporarily increased, which would of course produce an increased result. It may however be illustrated by a modification of the apparatus before described. Let the flexible globe be suspended by three weights with pulleys, representing as in a former case the sun's attraction, the weights being now connected with the several parts of the globe by *elastic* cords or bands, and

when the suspension is completed *clamp* the cords at the pulleys; they will then represent the constant action of the sun and at the same time allow the whole globe or any of its parts to move to a limited extent under the action of another force. By means of three other cords with pulleys, attach three additional weights to the same points to act in the same direction and thus to represent the *added* attraction of the moon; and by a proper adjustment of the second set of weights, and of the size or elastic force of the first set of cords, not only the increased elongation of the earth (the spring tides) belonging to this position of the other bodies, but its temporary approach to the sun, may be represented.

In the other case described, in which the attractions of the sun and moon are opposite in direction, (at full moon,) and still conspire to produce an increased result, some illustration may perhaps be more needful, and it is readily supplied by a further modification of the apparatus arranged as last described. Let the globe be suspended by the three elastic cords representing the sun's attraction, and clamped as before; but as these act upward, and the moon's attraction is now supposed to be opposite in direction to that of the sun, it may be represented by weights attached to the globe *directly* and acting downward: attach, therefore, in this manner, the other three weights to the bottom, the top, and the centre, respectively, to represent the attractive force of the moon at those three distances, and as the lower side of the globe now represents the side of the earth toward the moon acting from below, as the sun from above, it is obvious that the weight attached to the bottom must in this case be greater than that attached to the top. Now it is evident that under this arrangement of the forces the elongation of the globe must be increased by the addition of the second set of weights, and in like manner does the combined attractions of the sun and moon, though opposite in direction, produce the increased effect observed in the spring tides of full moon.

At the first and last quarters of the moon the direction of the sun's attraction is at right angles to that of the moon, and its disturbing influence must therefore act upon the equatorial portions of the earth's surface intermediate to those acted upon by the moon at the same time. Now we have seen that the effect of the disturbing influence of these bodies is to render the surface waters upon which it acts specifically lighter, and thus to disturb the exact equilibrium that would otherwise exist; these lighter portions being buoyed up to a higher level by those portions not so affected, which of course at the same time sink. But in the case we are now considering, while the moon's influence is producing the lunar tide on two opposite sides of the earth, the sun is at the same time acting upon the intermediate equa-

torial spaces and is thus diminishing to the extent of its influence the gravity of those very portions upon the weight of which the lunar tide in part depends.[1] The lunar tide will consequently be lessened by this action of the sun's influence, and hence the neap tides of the moon's first and last quarters. These neap tides may also be illustrated by the flexible globe; for if we have it merely suspended by three weights, as at first, but representing now the moon's attraction, and attach to two opposite sides two other weights with pulleys acting in a horizontal direction, these last may be regarded as representing the disturbing influence of the sun which acts *from the centre*, or in opposition to gravity on two opposite sides of the earth. Now these two weights, by drawing the two sides to which they are respectively attached nearer to their normal position or distance from the centre, or, in other words, by tending to elongate the globe in a direction at right angles to that of the moon's attraction, will lessen somewhat the vertical or lunar elongation.

In the intermediate positions, or between new moon and the first quarter, this quarter and full moon, and so on, the influence of the sun will vary from what it is at one of these extreme or turning points to what it is at the next; but to describe these changes—and the same may be said of numerous subordinate or collateral branches of this subject—does not fall within the scope of my present purpose; which was merely to point out a mode of presenting the essential features of the theory of the tides, calculated, as it seemed to me, to make it more easily and more fully understood than those in common use, and also to suggest some ocular illustrations.

[1] It will be observed that I say "in part," and speak above of "equatorial spaces," etc. There seems to be good reason to doubt whether in this connection one circumstance has been by any means properly attended to, namely, that the lunar tide may be raised in part, perhaps in some cases chiefly, by the pressure of those portions of the surface waters lying northward or southward of the central points of the moon's direct influence; these would be for the most part wholly undisturbed by the sun's influence. A lunar spheroidal wave is formed *theoretically* by pressure on *all* sides: the sun can materially interfere with its formation only on *two* (opposite) sides, namely, where the two antipodal centres of its influence approach, or fall upon, the edge of the wave. The theoretical proportion between spring and neap tides has been commonly, (not to say carelessly,) stated as that between the sum and *difference* of the two separate disturbing influences of the sun and moon, say as 7 to 3; but even theoretically this is manifestly incorrect, and, in point of fact, so far as I have observed, on the western shore of the North Atlantic, it does not approximate to the truth. Here, indeed, this northern and southern influence would seem to have freest scope, and in view of the eastern and western *boundaries* of this ocean, it seems not unlikely that it would be more consistent with the actual facts of the case to consider the neap tides *here* as the lunar tide *alone*, and the spring tides as the lunar and solar combined.

ART. XXV.—*Analysis of a Meteorite from Chili*; by CHARLES A. JOY, Professor of Chemistry in Columbia College, New York.

THIS meteorite was found on a mountain pass, about fifty miles from Copiapo, in the province of Atacama, Chili, by a native of the Argentine Republic, and presented to Mr. Joseph Brower, by whom it was brought to New York, and to whose kindness I am indebted for the fragment used in the analysis. The original specimen has been deposited by Mr. Brower, with a large collection of rare silver and copper ores from Chili, in the mineralogical cabinet at Union College, Schenectady.

The outer crust of the meteorite wore the usual dark red color of oxydized iron. Its weight, uncut, was 1784 grams. The specific gravity is 4·35. A polished etched surface gave an impression on paper of scattered points rather than of regular lines. It also readily reduced copper from its solutions.

A close inspection of the specimen shewed that there was a large per-centage of stony matter interspersed through the mass. The color and hardness of a portion of this indicated olivine; other fragments recalled the appearance of partially decomposed labradorite. An unsuccessful attempt was made to withdraw the iron by means of a magnet, but the powdered mineral adhered to the magnet in association with the iron.

For the determination of the sulphur, phosphorus, copper and tin, the presence of which had been revealed by a qualitative analysis, a large fragment was taken and treated with aqua regia, at a gentle heat. The sulphur separated in finely divided grains, and care was taken to prevent them from combining into compact masses. After gently heating in a water-bath for twenty-four hours, all of the sulphur was successfully oxydized. The portion of the meteorite insoluble in acids was collected upon a filter, dried, incinerated and weighed. From the solution, sulphuric acid was precipitated by chlorid of barium, the precipitate was heated with chlorhydric acid to free it from all traces of iron, filtered, dried and weighed. The filtrate from the sulphate of baryta gave a slight brown precipitate with sulphuretted hydrogen. This was dissolved in aqua regia, and saturated with ammonia, when a slight yellow precipitate of tin was thrown down, while copper was dissolved and afterward precipitated by potash.

After expelling the sulphuretted hydrogen from the first filtrate, the phosphorus was separated by molybdate of ammonia and afterward determined as phosphate of magnesia.

For the determination of the iron, alumina, nickel, cobalt, manganese, and lime, a second portion was taken and treated as before. The iron, alumina, nickel, cobalt, and manganese were successively precipitated by ammonia and sulphid of ammonium

and the precipitate redissolved and weighed. The iron and alumina were separated from the other bases by carbonate of baryta. The nickel, cobalt, and manganese, were not determined in this portion, but were precipitated by potash and weighed. The separation of the iron and alumina was accomplished by means of the hyposulphite of soda. The alumina was found to be free from the oxyd of chromium. The lime was determined as carbonate. For the separation of the nickel and cobalt from manganese, in another portion, the insolubility of the sulphids of nickel and cobalt in chlorhydric acid was used. To separate nickel and cobalt, I preferred the method of chlorine and carbonate of baryta which I had followed in Rose's laboratory. Liebig's process, which I employed with the Cosby Creek iron,[1] was inconvenient, and the method by nitrite of potassa did not yield satisfactory results, owing to impure materials and want of time to repeat the analysis.

Results:

	From 3·519 grams.	1·134 grms. insol.		2·385 grms. soluble.
	BaO, SO_3	0·688		0·0944 S
	MgO_2PO_5	0·015		0·00423 P
	CuO	0·002		0·00159 Cu
	SnO_2	0·001		0·001 SnO_2
No. 3.	Mn_3O_4	0·011	No. 2.	1·166 grms. material.
	Co_3O_4	0·021		0·390 grms. insoluble.
	NiO	0·124		0·776 " soluble.
		0·156		
	CaO, CO_2	0·025		0·014 CaO
	Fe_2O_3	0·859		0·6013 Fe
	Al_2O_3	0·039		0·039 Al_2O_3
	Mn_3O_4	0·006		0·00432 Mn
	NiO	0·077		0·06034 Ni (Calc. from No. 3.)
	Co_3O_4	0·013		0·00959 Co

From the above figures we obtain the following results:

Fe - - - - - - -	77·48 pr. ct.
Ni - - - - - - -	7·77 "
Co - - - - - - -	1·23 "
Mn - - - - - - -	0·55 "
CaO - - - - - - -	1·80 "
Al_2O_3 - - - - - -	5·02 "
S - - - - - - -	3·95 "
P - - - - - - -	0·17 "
Cu - - - - - - -	0·06 "
SnO_2 - - - - - - -	0·04 "
	98·07

[1] Ann. Chem. Pharm., lxxxvi, 39.

As the analysis was conducted with great care, and as we have alumina and lime evidently derived from the decomposition of a portion of the mineral, and as protoxyd of iron is easily attacked in silicates, it is proper to assume that the difference is due to oxygen combined with iron as protoxyd. Assuming 1·90 pr. ct. oxygen, we require 6·65 pr. ct. Fe to form 8·55 FeO. This will give us for the soluble portion:

Fe	70·83 pr. ct.	Mn	0·55 pr. ct.
Ni	7·77	Al_2O_3	5·02
Co	1·23	FeO	8·55
Cu	0·06	CaO	1·80
S	3·95	SnO_2	0·04
P	0·17		99·97

The average of several analyses gave 68·19 pr. ct. soluble in acids, and 31·81 pr. ct. insoluble in acids.

Insoluble mineral portion.

This was fused with carbonate of soda: an intense green color indicated the presence of manganese. The fused mass treated with water yielded a green solution of NaO, MnO_3, which turned red upon further heating, and colorless upon addition of alcohol. The solution was evaporated to dryness and the silica separated as usual. It was afterwards fused by itself and found to be pure and to contain no undecomposed mineral. Sulphuretted hydrogen was passed through the filtrate from the silica, by which a slight precipitate of a brown sulphid was produced. This was collected upon a filter, dried, treated with a few drops of aqua regia, incinerated and weighed. It was then nearly all dissolved in chlorhydric acid. Ammonia produced a yellow white precipitate of SnO_2, HO which becomes brown in NH_4S and was dissolved in an excess of that reagent and upon addition of HCl yielded brown sulphid of tin. The ammoniacal filtrate from SnO_2 was colored distinctly blue by copper.

The filtrate from the sulphid of tin and sulphid of copper was treated with chlorid of ammonium and ammonia and saturated with sulphid of ammonium and heated, by which iron, manganese, nickel, cobalt, and chromium were precipitated. This precipitate was dissolved in aqua regia. From the filtrate from the sulphur metals the lime was precipitated by oxalate of ammonia and the magnesia by phosphate of soda.

From the solution in aqua regia, the oxyds of iron, alumina, and chromium, were precipitated by carbonate of baryta in the cold. The excess of baryta was removed by sulphuric acid and the manganese precipitated by potash: this precipitate was examined for nickel and cobalt and found to contain traces.

The precipitate containing the oxyds of iron, alumina, and chromium, and excess of carbonate of baryta, was dissolved in chlorhydric acid, the baryta removed by sulphuric acid, and the iron and alumina separated by hyposulphite of soda.

The sesquioxyd of chromium was separated from the oxyds of iron and alumina, as follows: The Al_2O_3 was fused with NaO, Co_2 and KO, NO_5, the fused mass dissolved in water, saturated with chlorhydric acid and evaporated with additions of chlorate of potassa and the alumina precipitated with ammonia and the chromic acid as chromate of lead.

The Fe_2O_3 was also fused with carbonate of soda and nitrate of potassa, and the mass lixiviated with water, filtered, saturated with chlorhydric acid, alcohol added, heated to boiling, and the sesquioxyd of chromium precipitated by ammonia.

Results:

Substance taken = 0·518 grms.

Found, SiO_3	0·334 grms.	64·478 per cent.
FeO	0·0729	14·073
MgO	0·06737	13·005
MnO	0·01678	3·239
Cr_2O_3	0·00907	1·750–2·575 Cr_2O_3FeO
Al_2O_3	0·00593	1·144
CaO	0·00448	0·864
SnO_2+CuO	0·005	0·965
NiO, CoO	0·002	0·386
	0·51753	99·904

Second Analysis.

Substance taken = 1·114 grms.

Found, SiO_3	0·713	65·61 per cent.
MgO	0·1549	13·90
FeO	0·1647	14·78
Cr_2O_3	0·0140	1·25
Al_2O_3	0·0120	1·07
MnO	0·0325	2·91
CaO	0·0128	1·15
Ni, CO	0·0010	0·09
		100·76

Average.

SiO_3 - - - -	65·04
MgO - - - -	13·45
FeO - - - -	14·42
Cr_2O_3 - - -	1·50
Al_2O_3 - - -	1·10
MnO - - -	3·07
CaO - - -	1·01
Ni, Co - - -	0·23
	99·82

From these analyses we have the composition of the meteorite a whole, as follows:

Fe	48·298	per cent.
Ni	5·298	
Co	0·838	
Mn	0·375	
Cu	0·040	
S	2·693	
P	0·115	
SiO_3	20·689	insoluble.
MnO	0·976	"
Cr_2O_3	0·477	"
NiO, CoO	0·073	"
FeO	5·830	soluble.
FeO	4·587	insoluble.
CaO	1·227	soluble.
CaO	0·321	insoluble.
Al_2O_3	3·423	soluble.
Al_2O_3	0·349	insoluble.
MgO	4·278	"
SnO_2	0·027	soluble.
SnO_2	0·162	insoluble.
	100·076	

Metallic portion.		*Mineral portion.*		
Fe	48·298 per cent.	SiO_3	20·689 per cent.	
Ni	5·298	MnO	0·976	
Co	0·838	Cr_2O_3	0·477	
Mn	0·375	NiO, CoO	0·073	
Cu	0·040	FeO	10·417	
S	2·693	MgO	4·278	
P	0·115	Al_2O_3	3·772	
	57·657	CaO	1·548	Another anal.
		SnO_2	0·189	0·332
			42·419	

In 100 *parts.*

Metallic.		Mineral.		
Fe	83·76	SiO_3	48·61	
Ni	9·18	FeO	24·47	
Co	1·45	MgO	10·05	
Mn	0·65	Al_2O_3	8·86	
Cu	0·07	CaO	3·63	
P	0·20	MnO	2·29	
S	4·67 (12·84 FeS.)	Cr_2O_3	1·12	
	99·98	NiO, CoO	0·17	Another anal.
		SnO_2	0·44	0·78
			99·64	

If we examine the mineral portion under a microscope and study its behavior towards reagents, we shall find at least two silicates in the meteorite; one of them, like olivine, having the formula $RO_3\ SiO_3$, not so easily attacked by acids, and the other resembling labradorite, with the formula $x R_2O_3\ SiO_3 + y RO\ SiO_3$. Assuming that the Cr_2O_3 was combined with the FeO as chrome iron, the 1·12 Cr_2O_3 will require 0·52 FeO, which must be deducted from the 24·47 pr. ct. FeO. Assigning MgO, MnO, NiO, CoO, to the mineral RO^3, SiO_3 and the Al_2O_3, CaO, to the mineral $x R_2O_3\ SiO_3 + y RO\ SiO_3$, and dividing the FeO between them, we have for the mineral portion:

Chrome iron - -	1·64 pr. ct.	Cr_2O_3 FeO
Olivine, - -	27·43	$RO_3\ SiO_3$
Labradorite - -	70·13	$Al_2O_3\ SiO_3 + 4RO\ SiO_3$
	99·20	

This will give for the composition of the meteorite:

Nickel iron (with Co, Mn, and Cu)	48·689
Sulphid of iron, FeS	7·405
Chrome iron, Cr_2O_3 FeO	0·701
Schreibersite, (Fe 1·38, Ni 0·67, P 0·115)	1·563
Olivine, $RO_3\ SiO_3$	11·677
Labradorite,* (R_2O_3, $SiO_3 + 4RO\ SiO_3$)	29·852
Tin stone, SnO_2	0·189
	100·076

Calculations were made referring the silicates to hornblende, hypersthene, augite, and anorthite, but I omit them in the summary as being of a purely theoretical character. The above is believed to give the fair average constitution of this meteorite.

I must express my obligation to my assistant, Mr. Charles A. Stetefeldt, for skillful aid in hastening the completion of the analysis.

New York, Jan. 1st, 1864.

Art. XXVI.—*Contributions to Lithology;* by T. Sterry Hunt, M.A., F.R.S.; of the Geological Survey of Canada.

I. *Theoretical Notions.*—II. *Classification and Nomenclature.*

In a recent paper on *The Chemical and Mineralogical Relations of Metamorphic Rocks* (this *Journal*, [2] xxxvi, 214), an attempt was made to define the principles which have presided over the formation of sedimentary rocks, and to explain the nature and conditions of their alteration or metamorphism. That paper

* The absence of soda is disregarded in the calculation of the formula.

may be considered as to a certain extent introductory to the present one, which will contain, in the first part, some theoretical considerations which it is conceived should serve as a basis to lithological studies. In the second part will be given a few definitions which may serve to render more intelligible the classification and nomenclature of crystalline rocks; while a third part will contain the results of the chemical and mineralogical examination of some of the eruptive rocks of Canada. These results will be found for the most part in the recently published volume entitled the *Geology of Canada.*

I.

I have already, in other places, expressed the opinion that the various eruptive rocks have had no other origin than the softening and displacement of sedimentary deposits; and have thus their sources within the lower portions of the earth's stratified covering, and not beneath it. The theory which conceives them to have been derived from a portion of the interior of the earth still retaining its supposed primitive condition of igneous fluidity, is in my opinion untenable. It is not here the place to discuss the more or less ingenious speculations of Phillips, Durocher, and Bunsen as to the constitution of this supposed fluid centre, nor the more elaborate hypothesis of Sartorius von Waltershausen as to the composition and arrangement of the matters in this imaginary reservoir of plutonic rocks. The immense variety presented in the composition of eruptive masses presents a strong argument against the notion that they are derived, as these writers have supposed, from two or more zones of molten matter, differing in composition and density, and lying everywhere beneath the solid crust of the earth; which, in opposition to the views of many modern mathematicians and physicists, the school of geologists just referred to regard as a shell of very limited thickness.

The view which I adopt is one the merit of which belongs, I believe, to Christian Keferstein, who, in his *Naturgeschichte des Erdkörpers*, published in 1834, maintained that all the unstratified rocks, from granite to lava, are products of the transformation of sedimentary strata, in part very recent; and that there is no well defined line to be drawn between neptunian and volcanic rocks, since they pass into each other, (vol. i, p. 109). This view was subsequently, and it would seem, independently brought forward in 1836 by Sir John Herschel, who sought to explain the origin of metamorphism and of volcanic phenomena by the action of the internal heat of the earth upon deeply buried sediments impregnated with water. (*Proc. Geol. Soc.* of London, vol. ii, pp. 548, 596.) See also my papers in the *Canadian Journal*, 1858, p. 206; *Quart. Jour. Geol. Soc.* 1859, p. 488; *Can. Naturalist*, Dec. 1859, and *this Journal*, [2], vol. xxx, p. 135.

The presence of water in igneous rocks, and the part which it may play in giving liquidity to all volcanic and plutonic rocks was insisted upon by Poulett Scrope, so long ago as 1824, in his *Considerations on Volcanos*, (see also *Quart. Jour. Geol. Soc.* London, xii, 341.) This view has since been ably supported by Scheerer in his discussion with Durocher. (*Bul. Soc. Geol. France*, [2], iv, 468, 1018; vi, 644; vii, 276; viii, 500.) See also Elie de Beaumont, *ibid.*, iv, 1312. The admirable investigations of Sorby on the microscopic structure of crystals, (*Quart. Jour. Geol. Soc.*, xiv, 453) have since demonstrated that water has intervened in the crystallization of almost all plutonic rocks. He has shown the quartz both of granites and of crystalline schists contains great numbers of small cavities partially filled with water, or with concentrated aqueous solutions of chlorids and sulphates of potassium, sodium, calcium and magnesium, sometimes with free chlorhydric acid. Similar fluid cavities were found by him in most crystals artificially formed in aqueous solutions, and were also observed in the minerals from the limestones of Vesuvius, where they occur in nepheline, idocrase, hornblende and feldspar; the liquid in the latter crystals containing, besides chlorids and sulphates, alkaline carbonates. Mr. Sorby has also described the cavities filled with vitreous and with stony matters which he has observed in quartz, in the feldspar of pitchstones, in augite, leucite and nepheline; and which are sometimes found associated with fluid-cavities in the same mineral. As these fluid-cavities enclosed the liquid at an elevated temperature, its subsequent cooling has produced a partial vacuum, which is again filled on heating the crystal; so that the temperature of the crystals at the time of their formation may be approximatively determined. Mr. Sorby concludes that every peculiarity in the structure of the quartz of the veins in Cornwall, "may be most completely explained by supposing that this mineral was deposited from water holding various salts and acids in solution, at temperatures varying from 200° C. to a dull red heat visible in the dark" (about 340° C.) At this highest temperature he conceives that other minerals, such as mica, feldspar and tinstone were deposited, the latter mineral containing numerous small fluid-cavities. In like manner, he deduces from the fluid-cavities in the Vesuvian minerals just noticed, a temperature of from 360° to 380° C. The presence, at the same time, of bubbles or vapor-cavities and of glass and stone-cavities in these crystals shows them to have been formed "at a dull red heat under a pressure equal to several thousand feet of rock, when water containing a large quantity of alkaline salts in solution was present, along with melted rock, and various gases and vapors. * * * * I therefore think that we must conclude provisionally, that at a great depth from the surface, at the foci of

volcanic activity, liquid water is present along with the melted rocks, and that it produces results which would not otherwise occur." (*loc. cit.*, p. 483.)

Mr. Sorby has, as we have just seen, determined the temperature requisite to expand the liquid so as to fill the fluid-cavities, provided they were formed under a pressure not greater than the elastic force of the vapor. This of course represents the lowest temperature at which the consolidation could have taken place, and varies from 340° to 380° in the Vesuvian minerals, and 356° in the quartz of the trachyte of Ponza, to a mean of 216° in the Cornish granites, to 99° in those of the Scottish Highlands, and even descends to 89° in some parts of the granite of Aberdeen. But this low temperature is improbable, and inasmuch as water and aqueous solutions are compressible, their volume would be considerably reduced under a great pressure of superincumbent rock. Mr. Sorby has therefore calculated the pressure in feet of rock which would be required to compress the liquid so much that it would just fill the cavities at 360° C. The numbers thus obtained will therefore represent the actual pressure, provided the rock was in each case consolidated at that temperature. It would thus appear that the trachyte of Ponza was solidified near the surface, or beneath a pressure of only 4000 feet of rock; while for the Aberdeen granite the pressure was equal to not less than 78,000 feet, and for the mean of the Highland granites 76,000. The Cornish granites vary from 32,400 to 63,600, and give, as a mean, 50,000 feet of pressure. In this connection Mr. Sorby remarks that from Mr. Robert Hunt's observations on the mean increase of temperature in the mines of Cornwall, a heat of 360° C. would be attained at a depth of 53,500 feet.

The observations upon the metamorphic crystalline schists in the vicinity of these various granites show that their constituent minerals must have crystallized at about the same temperature as the granite itself; affording, as Mr. Sorby observes, "a strong argument in favor of the supposition that the temperature concerned in the normal metamorphism of gneissoid rocks was due to their having been at a sufficiently great depth beneath superincumbent strata;" and he concludes that with regard to rocks and minerals formed at high temperatures, we have "at one end of the chain erupted lavas, indicating as perfect and complete fusion as the slags of furnaces, and at the other end simple quartz veins, having a structure precisely analogous to that of crystals deposited from water. Between these there is every connecting link, and the central link is granite." When the water, which at great depths was associated with the melted rock, was given off as vapor while the mass remained fused, slag-like lavas resulted. If however the water could not escape in

vapor, it remained, as we have seen, to take its part in the crystallization, in some cases forming hydrated minerals; and the excess of it, as Mr. Sorby suggests, passed up as a highly heated liquid, holding dissolved materials, which would afterwards be deposited in the form of mineral veins in the fissures of superincumbent rocks.

I have thought it well to give at some length the remarkable results and conclusions by Mr. Sorby, because I conceive that they have not as yet received the full degree of consideration to which they are entitled, and are perhaps little known to some of my readers.[1] The temperature deduced by him from the examination of the crystals of hornblende and feldspar from Vesuvius is curiously supported by the experiments of Daubrée; who obtained crystallized pyroxene, feldspar and quartz, in presence of alkaline solutions, at a temperature of low redness; while De Senarmont crystallized quartz, fluor-spar and sulphate of barytes in presence of water, at temperatures between 200° and 300° C. At the same time the deposits from the thermal waters at Plombières show that crystalline hydrous silicates, such as apophyllite, harmotome, and chabazite, have formed at temperatures but little above 80° C.

We conceive that the deeply buried sedimentary strata, under the combined action of heat and water have, according to their composition, been rendered more or less plastic, and in many cases have lost to a greater or less degree the marks of their sedimentary origin, although still retaining their original stratigraphical position. In other cases they have been displaced, and by pressure forced among disrupted strata, thus assuming the form of eruptive rocks; which, becoming consolidated under a sufficient pressure, retain the same mineral characters as in the parent beds. It is only those rocks which, like lavas, have solidified at or near the surface of the earth, and consequently under feeble pressure, which present mineralogical characters dissimilar to those of the undisturbed crystalline sediments. With this exception the only distinction which can be drawn between stratified and unstratified masses must in most cases be based upon their position, and their relation to the adjacent rocks.

In view of these considerations I have, in previous papers, adopted for geological purposes a division of crystalline rocks into indigenous rocks, or sediments altered *in situ*, and exotic rocks, or sediments displaced and translated, forming eruptive and intrusive masses. Under the head of exotic rocks is however to be included another class of crystalline aggregates, which are for the most part distinguished by their structure from injected or intrusive masses. I refer to the accumulations which

[1] See further the late observations of Zirkel confirming those of Sorby, *Proc. Imp. Acad. Vienna*, March 12, 1863; in abstract in *Quart. Jour. Geol. Soc.*, vol. xix.

ıineral veins, and which doubtless have been deposited from ɔus solutions. While their peculiar arrangement, with the ›minance of quartz and non-silicated species, generally s to distinguish the contents of these veins from those of ;ed plutonic rocks, there are not wanting cases in which the ›minance of feldspar and mica gives rise to aggregates which a certain resemblance to dikes of intrusive granite. From , however, true veins are generally distinguished by the pres- of minerals containing boron, fluorine, phosphorus, cæsium, .ium, lithium, glucinum, zirconium, tin, columbium, etc.; ele- s which are rare, or are found only in minute quantities in reat mass of sediments, but are here accumulated by depo- ı from waters which have removed these elements from the ıentary rocks and deposited them subsequently in fissures. › one at the present day will probably be found to deny the nic origin of most non-stratified rocks, so that the once d questions of the neptunist and plutonist may be regarded ttled. If, however, we go back but a few years in the his- of geology, it will be found that an eruptive origin was then ıed for many rocks which are now admitted to be indige-

It is scarcely necessary to refer to the views of those have maintained the exotic character of many quartzites ;rystalline limestones, when a majority of writers, even to ›resent day, class serpentines, euphotides, and hyperites g eruptive rocks; although the experience of every field- gist is accumulating, from year to year, a great mass of evi- : in favor of the indigenous nature of all these rocks. The ıentary and indigenous character of very many granites, tes, and diorites, will now no longer be questioned. Thus ıd, for example, that the melaphyres of the Tyrol, which, ›n Buch's too famous theory of dolomitization, were sup- . to have been erupted together with magnesian vapors ı affected the alteration of the adjacent limestones, have shown by Fournet to be sediments of Carboniferous age, norphosed *in situ*,—indigenous rocks, which were altered e the Jurassic dolomites were deposited, (*Bul. Soc. Geol.* :*e*, [2], vi, 506–516). In like manner we find Scipion Gras uding from his researches on the anthracitic rocks of the that the serpentines, euphotides, porphyries, and spilites, ı are there found associated with crystalline schists, are all dimentary origin, but have been so profoundly altered *in* s to have lost nearly all traces of sedimentary origin (*Ann.* *ines*, [5], v, 475). We might add that the tendency of re- investigations has been to show that the protogines, or gran- f the summit of the Alps, are Tertiary strata altered in ; thus confirming the bold assertion made by Keferstein in

1834, that these granites are altered strata of *flysch.* (*This Journal*, [2], xxix, 123, 124.) Lesley's recent investigations of the granites of the White Mountains of New Hampshire, show them to be clearly stratified sedimentary deposits in nearly horizontal layers. (*American Mining Journal*, 1861, p. 99; this *Journal*, [2], xxxi, 403.) The ophites (amphibolites) of the Pyrenees, which by Dufrenoy and other French geologists, have been regarded as eruptive, and were by the former imagined to be in some mysterious manner related to the rock-salt and gypsum of the region, which he supposed to be, like the ophites, of posterior origin to the enclosing strata, (*Explic. de la Carte Geol. de France*, i, 95,) are according to a recent note by Virlet, not eruptive, but altered indigenous rocks, belonging, together with the associated gypsum and saliferous strata, to the Triassic series. (*Comptes Rendus de l'Acad.*, Aug. 1863, p. 232.)

It would be easy to multiply examples of this kind, which show that a careful study of very many of the crystalline rocks, hitherto regarded as eruptive, leads to the conclusion that they are really indigenous rocks. At the same time many of these indigenous rocks appear to have been at one time in a soft semi-fluid condition, which permitted movements obliterating the marks of sedimentary origin, and producing other results which show the passage into eruptive rocks. Thus the crystalline limestones of the Laurentian series in Canada are frequently interstratified with thin beds of gneiss and quartzite, both of which are often found broken, contorted, and even twisted spirally, in a manner which indicates great flexibility of the siliceous layers, as well as violent movements in the calcareous rock. The latter is in some cases found in the form of thin seams or considerable dykes among the adjacent broken siliceous strata, thus assuming for small distances, the characters of an intrusive rock. For some figures and descriptions illustrating these broken and distorted strata, see *Geology of Canada*, pp. 27, 28. We may also allude in this connection to the observations of Dr. Hitchcock among the altered strata of the Green Mountains, which seem to show that the pebbles of gneiss and quartz in certain conglomerate beds have been so softened as to have been flattened, laminated, and bent around each other. (*This Journal*, [2], xxxi, 372.) Hence, while the tendency of the various observations above cited is in favor of the indigenous character of many rocks hitherto regarded as eruptive, we have at the same time evidence that these rocks are occasionally displaced. We should not therefore on *a priori* grounds reject the assertion that any metamorphic sediment may sometimes occur in an exotic or intrusive form. A given rock, like limestone or diorite, may occur both as an indigenous and an exotic rock; and different portions of the same mass may be seen by different observers under such

unlike conditions that one may regard it as indigenous, and the other, with equal reason, may set it down as intrusive. It is evident then that to the lithologist, who examines rocks without reference to their geological relations, the question of the exotic or indigenous character of a given rock is, in most cases, one altogether foreign; and one which can frequently be decided only by the geologist in the field. Hence, although generally made a fundamental distinction in classification, it will be disregarded in the following sketch of the nomenclature of crystalline rocks.

I may here allude to a fact which I have already noticed, and tried to explain, (*this Journal*, [2], xxxi, 414, and xxxvi, 220, *note*,) that throughout the great metamorphic belt which constitutes the Appalachian chain, exotic rocks are comparatively rare, (at least in New England and Canada); but abound, on the contrary, among the unaltered strata on either side. Illustrations of this are seen in the valley of Lake Champlain, and in its northward continuation toward Montreal, in those of the Hudson and Connecticut, and in the northeastward continuation of the latter valley by Lake Memphramagog to the Bay of Chaleurs, which is marked throughout by intrusive granites. In accordance with the reasons already assigned for this distribution of exotic rocks it is probable that a similar condition of things will be found to exist in other regions; and that eruptive rocks will, as a general rule, be found among unaltered, rather than among metamorphic strata. It is of course possible that a crystallization of the sediments may in some cases take place subsequent to the eruption of foreign rocks into their midst. The rarity of intrusive rocks among crystalline strata, not less than the unaltered condition of sediments which are traversed by abundant intrusive masses, is a strong proof of the fallacy of the still generally received notion which connects metamorphism with the contiguity of eruptive rocks.

II.

It is proposed in this second part, to describe briefly the composition, structure and nomenclature of the various crystalline silicated rocks, considered without reference to the distinction between indigenous and intrusive masses. Comparatively few of these rocks are homogeneous, or consist of a single mineral species, and the names which have been applied to varying mixtures of different species are of course arbitrary; and as they have often been given without any previous mineralogical study it sometimes happens that, as in the case of the rocks composed of anorthic feldspars and pyroxene, different names have been proposed for varieties very closely related, or differing from one another only in texture or in structure.

The minerals essential to the composition of the rocks under consideration are few in number, and are as follows: quartz, orthoclase; a triclinic feldspar which may be albite, oligoclase, andesine, labradorite or anorthite; scapolite, leucite, nepheline, sodalite; natrolite, or some allied zeolite; iolite, garnet, epidote, wollastonite, hornblende, pyroxene, olivine, chloritoid, serpentine, diallage; muscovite, phlogopite, and some other micas; chlorite, and talc. To these may be added as accidental ingredients, the carbonates of lime, magnesia, and protoxyd of iron, together with magnetite, ilmenite and sphene. The silicates which, like tourmaline, beryl, zircon, spodumene, and lepidolite, contain considerable portions of the rarer elements, and often occur with quartz and feldspar in granitic veins, whose origin has already been alluded to, enter at most in very small quantity into great rock masses.

The varieties of structure in crystalline rocks are the more deserving of notice as they have led to a great multiplication of names. We may note first the granitoid structure, in which the mineral elements are distinctly crystalline, as in granite. From this, there is a gradual passage through granular into compact varieties of rock. Most of these are simply finely granular, and are rightly entitled to the distinction of crypto-crystalline; but others, like the pitchstones, obsidians and lavas, are apparently amorphous, and are natural glasses. In some cases the constituent minerals may be so arranged as to give a schistose or gneissoid form to a rock. This arrangement is generally to be looked upon as an evidence of stratification, but something similar is occasionally observed in eruptive masses. In the latter case it generally seems to arise from the arrangement of crystals during the movement of the half-liquid crystalline mass, but it may in some instances arise from the subsequent formation of crystals arranged in parallel planes.

See on this point Naumann *On the probable eruptive origin of several kinds of gneiss, etc.;* Leonhard and Bronn, *Neues Jahrbuch* for 1847, and Poulett Scrope, *Geol. Journal*, xii, 345. I consider however that their views are to be adopted with great reserve, and admitted only in a very few cases. The ribbanded structure of some porphyries and clinkstones, as noticed by Scrope, is undoubtedly the result of movements in the liquid mass, and the same is true of some of the granitoid dolorites to be described in the third part of this paper; but the eruptive origin assumed by Darwin, Naumann, and some others for great areas of gneiss and gneissoid granite, seems to a student of the crystalline rocks of this continent utterly untenable. As has been already remarked, the progress of each year's investigation restores to the category of indigenous rocks many of those previously regarded as eruptive, and will, I am convinced, confirm

the principle which I have laid down of the comparative rarity of exotic rocks in crystalline and metamorphic regions.

Occasionally the crystallization of a rock takes place around certain centres, giving rise to rounded masses which have a radiated or a concentric structure, and constitute the so-called globular or orbicular rocks. Distinct crystals of some minerals, generally feldspar, augite, or olivine, are often found imbedded in rocks having a compact base. To such rocks the name of porphyry is given, and by analogy a rock with a granular base enclosing distinct crystals is designated as porphyritic or porphyroid. Amorphous or vitreous rocks, as pitchstones, are in like manner sometimes porphyritic. The name of porphyry, at first given to a peculiar type of feldspathic rocks, has now become so extended that it is to be regarded as only indicating an accident of structure. The title of amygdaloid is given to various rocks having rounded cavities which are wholly or partially filled with various crystalline minerals. The base of these rocks is generally granular or crypto-crystalline, but is sometimes amorphous, resembling a scoria or vesicular lava, the cavities of which have been filled by infiltration. Such is doubtless the origin of some amygdaloids. In more cases however these cavities have probably been formed like those often found in dolomites and some other rocks, by a contraction during solidification. Porphyroid rocks, in which quartz, orthoclase and other minerals are arranged in orbicular masses, are also sometimes designated amygdaloids, and may be confounded with the two previous classes in which the imbedded minerals are the result of subsequent infiltration. Allied in structure and origin to the last are what are named variolites or variolitic rocks. (See *Geology of Canada*, pp. 606, 607.)

The masses into which some aluminous minerals enter as a prominent element constitute by far the greater part of the rocks now under consideration. These are naturally divided into two classes, whose origin we have pointed out in a recent paper already referred to. (*This Journal*, [2], xxxvi, 218.) The first of these is characterized by containing an excess of silica, with a portion of alumina, much potash, and small portions only of lime, magnesia and oxyd of iron. The second class contains a smaller amount of silica, and larger proportions of alumina, lime, magnesia and oxyd of iron, with soda, and but little potash. These chemical differences are made apparent in the more coarsely crystalline rocks, by the nature of the constituent minerals; and in the compact varieties by differences in color, specific gravity and hardness. Thus in the rocks of the first class the predominant mineral is orthoclase, generally associated with quartz, and the composite rocks of this class seldom have a density much above that of these species; or from 2·6 to 2·7. In the second class, the characteristic mineral is a triclinic feldspar, with pyrox-

ene or hornblende, the feldspar sometimes predominant; while in other cases the pyroxene or hornblende makes up the principal part of the rock. The presence of these latter minerals generally gives to the fine grained rocks of this class a dark color, a hardness somewhat inferior to the more siliceous class, and a density which may vary from 2·7 to more than 3·0. It will however be found that the line between the two classes cannot always be distinctly drawn, inasmuch as rocks containing orthoclase and quartz often include triclinic feldspars such as albite and oligoclase, and by an admixture of hornblende offer a transition to rocks of the second class. On the other hand, quartz is sometimes found with triclinic feldspars and hornblende in the rocks of the second class. Besides these two feldspathic classes, there is a third small but interesting group, in which an aluminous silicate of high specific gravity, such as garnet, epidote, or zoisite replaces the feldspar wholly or in part. These minerals being basic silicates rich in alumina, the relations of this group are naturally with those of the second class, although varieties of these species are found in rocks which belong to the first class.

The silico-aluminous crystalline rocks may thus be conveniently divided into three families. The first of these includes those rocks in which the aluminous mineral is orthoclase, (orthose) from which they may be conveniently designated by the name of the *orthosite* family. The second includes those in which the aluminous element is an anorthic or triclinic feldspar, and may be designated as the *anorthosite* family; chemically related to this are those rocks holding as one of their elements nepheline, leucite, or scapolite. The third family includes those rocks which contain an aluminous silicate of high density, as epidote, zoisite, garnet, andalusite, or kyanite, in place of a feldspathide. Iolite or dichroite, which enters into the composition of some orthosite rocks, appears from its atomic volume to be related to the feldspars, and should take its place along side of anorthite and scapolite as a magnesian feldspathide, while beryl in like manner appears to be a glucinic feldspathide.

It is worthy of notice that some feldspars having the crystallization and density of orthoclase, nevertheless contain large proportions of soda. The loxoclase of Breithaupt appears from the analysis of Smith and Brush to be a true soda-orthoclase; (*this Journal*, [2], xvi, 43,) while the sanidine or glassy feldspar of many trachytes contains potash and soda in nearly equal proportions. The name of potash-albite has been given to some feldspars of this composition, but the trachytic rocks hereafter to be described contain feldspars, which without being glassy, have the composition of sanidine, together with a cleavage and specific gravity which show them to belong to orthoclase rather than to albite. The anorthic feldspars offer in their composition such

gradations from albite to anorthite that the various intermediate species which have been distinguished seem to pass into each other. (*This Journal*, [2], xviii, 270. *Phil. Mag.* [4], ix, 262.)

Next to the feldspars in lithological importance are the two species, pyroxene and hornblende. These are sometimes found associated in the same rock, and the varieties of pyroxene known as diallage and smaragdite are frequently surrounded or penetrated by hornblende. This association of the two species should be kept in mind, inasmuch as the substitution of pyroxene for hornblende in anorthosites, has been made the basis of a subdivision in classification. (*This Journal*, [2], xxvii, 339.) Among the micas found in silicated rocks, besides muscovite and a magnesian mica (phlogopite or biotite), are to be included the hydrated micas observed by Haughton in many of the Irish granites. Of these the one is margarodite, and the other a uniaxial black mica, also hydrated, which he has referred to lepidomelane; (*Trans. Royal Irish Acad.*, xxiii, 593.) The presence of from four to six hundredths of water in the micas of these granites is important in connection with the evidence already given of the intervention of water in the formation of granitic rocks. These two hydrous micas were often found by Haughton to be united in the same crystal; and Rose has remarked a similar association of potash-mica and magnesian mica in certain granites (*Senft, die Felsarten*, p. 206.)

A scientific nomenclature for compound rocks presents such great difficulties that we must be content for the most part with trivial names which have been from time to time imposed. In the case of simple rocks the terms quartzite, pyroxenite, anorthosite, and orthoclasite are sufficiently definite, or they may be further characterized as normal orthoclasite, etc.; while quartzose, micaceous, and quartzo-micaceo-hornblendic orthoclasite would designate various compound rocks of which orthoclase is the base. Such names, however descriptive, will never replace the older terms granite, syenite, etc., which are employed to designate certain forms of orthosite rocks. The frequent association of a triclinic feldspar (oligoclase) with orthoclase in granite rocks, and the partial or total replacement of the micas generally present in these, by hornblende, by chlorite, or by talc; giving rise in the latter case to what is called protogine, are well known. Nepheline (elæolite), natrolite, iolite, and magnetite are sometimes found as elements in granitic, gneissic and syenitic rocks. The name of miascite is given to a granitic mixture of orthoclase and black mica with elæolite, sometimes with hornblende, albite, and quartz.

The structure of these orthosite rocks gives rise also to a great variety of names; thus to coarsely lamellar granites the name of pegmatite is sometimes given, while fine grained mixtures of

orthoclase and quartz have received the names of granulite, leptinite and eurite, or, when apparently homogeneous and crypto-crystalline, petrosilex. These latter forms often become porphyritic from the presence of crystals of orthoclase, giving rise to orthoclase-porphyry, or orthophyre. In some of these porphyries, as in those of Grenville to be described in the third part of this paper, quartz is also present in distinct grains or crystals; while in some of the red antique porphyries the feldspathic base contains no excess of silica, and occasionally encloses crystals of oligoclase or of hornblende. In many cases the granites, syenites, orthophyres, and other orthosite rocks just mentioned are intrusive, while in other instances rocks lithologically indistinguishable from these are indigenous, and becoming schistose pass into gneiss and mica-shist.

The rocks to which the name of trachyte has been given are generally composed in great part of orthoclase, (sanidine). The typical varieties of these rocks are white or of pale colors, granular or finely crystalline, and frequently porous or cellular. They appear to consist of grains, crystals or lamellæ of orthoclase, aggregated without any cementing medium, and to this seems to be due that roughness to which the rock owes its name. Oligoclase, quartz, hornblende and mica are also met with in this rock, which becoming coarsely granular, passes into granite. Such is the case with the trachytes of the Sierra of Carthagena in Spain, described by Fournet as passing from a dull rough grayish feldspathic mass, into a highly crystalline aggregate of feldspar and mica, with or without hyaline quartz, enclosing hornblende, red garnet, and fine blue iolite (*Comptes Rendus*, xliv, p. 1834.)

The trachytic texture is not confined to orthosite rocks. Abich has described under the name of trachy-dolerites a group of trachytoid anorthosites, (dolerites). The cone of the Soufrière of Guadalope is described by Deville as a rough granular rock having the external characters of trachyte, from which it is distinguished by its somewhat greater density, (2·75). It consists essentially of labradorite, with a little quartz, pyroxene, olivine, and magnetite. (*Bul. Soc. Geol. de France*, [2], viii, 425.) Humboldt designates the trachy-dolerites of Etna and of the peak of Teneriffe as trachytes, (*Comptes Rendus*, xliv, 1067); so that this word, like porphyry, comes to indicate nothing more than a peculiarity of structure, which may be assumed by various feldspathic rocks. The trachytic orthosites, as we have seen, pass into granites, from which they do not differ in chemical composition; and their differences in texture probably depend upon the fact that the one was solidified under great pressure, and the other near the surface, trachytes passing in fact into lavas. The observations of Sorby on the fluid-cavities in the crystals of granite and trachyte are in point.

Among the intrusive rocks of Canada, to be described, are granitoid, compact, and earthy varieties of trachytic orthosites, besides trachytic porphyries. These rocks often contain disseminated earthy carbonates, sometimes in considerable amount; as Deville had already shown for some of the trachytes of Hungary, and as I have also observed for those of the Siebengebirge on the Rhine. Trachytes also hold in some cases disseminated portions of a zeolite, apparently natrolite, and through this mixture pass into phonolites, of which a characteristic variety will be noticed in this paper. Obsidian and pumice-stone, which are often associated with orthoclase trachytes, are related to them in composition; and pitchstone and perlite are similar rocks, differing however in containing some combined water. Rocks resembling pitchstone, and sometimes porphyritic from the presence of distinct crystals of feldspar, occur in the south side of Michipicoten Island, Lake Superior, but have not yet been examined. Analyses by Jackson and by Whitney of the pitchstones of Isle Royale will be found in this Journal, [2], xi, 401 and xvii, 128.

The presence of anorthic feldspar, generally oligoclase, in many granites and trachytes, not less than the admixture of orthoclase crystals in some of the trachytic-dolerites of Etna, serves to connect the orthosite with the anorthosite family. Great masses of indigenous rock in the Labrador series in Canada, are made up of almost pure granular labradorite, or related triclinic feldspars, and might be termed normal anorthosites, (*this Journal*, [2], xxxvi, 224; *Geol. of Canada*, 588). In most cases, however, these feldspars are intermingled with some other mineral, commonly hornblende or pyroxene.

The name of diorite is by good authorites restricted to rocks whose predominant elements are triclinic feldspars with hornblende, while the names of diabase and dolerite distinguish those rocks in which pyroxene takes the place of hornblende. In some anorthosite rocks however, pyroxene and hornblende are intimately associated, so that a passage is established from diorite to diabase. The feldspar of diorites varies in composition from albite to anorthite, and is occasionally accompanied by quartz. This, though most frequent with the more siliceous feldspars, is sometimes met with in diorites which contain feldspars approaching to anorthite in composition. Sometimes the two constituent minerals are distinct and well crystallized, constituting a granitoid rock: fine examples of this, hereafter to be described, occur in the intrusive hills of Yamaska and Mount Johnson. At other times the diorite is finely granular or compact, when its color is generally of a green more or less dark from the disseminated hornblende, and it takes the name of greenstone. The greenstones of the Huronian series are in part at least diorites,

and probably indigenous, but a great number of the so-called greenstone-traps are pyroxenic, and belong to the class of diabase or dolerite. Diorite not unfrequently contains a mica, which is generally brown or black in color. Chlorite, magnetite, ilmenite and sphene often occur as disseminated minerals, as also carbonates of lime, magnesia and oxyd of iron. The finer grained diorites are frequently porphyritic from the presence of crystals of feldspar or of hornblende. Occasionally this rock is concretionary in its structure, as in the obicular diorite or napoleonite of Corsica; which contains a feldspar allied to anorthite, with hornblende, and some quartz. The norite from Sweden is a granular mixture of a similar kind, containing also mica; and the ophite of some writers is a diorite in which hornblende greatly predominates.

The rocks which are essentially composed of anorthic feldspar and pyroxene, present still greater diversities than the diorites, and have received various names based upon differences in texture and in the form of the pyroxenic element. It is here proposed to restrict the name of dolerite to such of these rocks as contain the black augitic variety of pyroxene, and to include the mixtures of triclinic feldspars with all the other varieties of this species under the head of diabase. The finer grained and impalpable varieties of diabase have received the name of aphanite, which is often indistinguishable from the corresponding forms of diorite, and like these may become porphyritic, giving rise to the augite-porphyry of some authors. Different varieties of this porphyry have received the name of labradophyre, oligophyre, and albitophyre, according to the composition of the imbedded feldspar crystals. These are sometimes accompanied by crystals of augite, or are altogether replaced by them.

The name of hyperite or hypersthenite has been given to those varieties of diabase which contain hypersthene or diallage. These rocks occur abundantly in the Labrador series, where the hypersthene in them sometimes takes the form of a green diallage, or passes into a finely granular pyroxene, and is associated with red garnet, ilmenite, and a little brown mica; in addition to which epidote is said to occur in the hyperites of the same series in New York, and olivine is mentioned as being found in the hyperites of Sweden, and of the Island of Skye. Hornblende is also in some localities associated with the hypersthene. The hyperites, although indigenous rocks in the Labrador series in Canada, are described as forming in other regions intrusive masses.

Those varieties of diabase or hyperite which contain diallage have, by the Italian lithologists been called granitone, but by Rose and others have been described under the name of gabbro. This rock sometimes contains hornblende, mica, and an admix-

ture of epidote. A compact white or greenish-white epidote, or zoisite, which has the hardness of quartz and a density of 3·3, to 3·4, is the mineral named saussurite. This with smaragdite, which is an emerald-green pyroxene, often mingled with hornblende, and passing into diallage, forms the euphotide of Hauy. Compact varieties of labradorite and of other triclinic feldspars have by most of the modern lithologists been confounded with saussurite, and hence the name of euphotide is frequently given to the so-called granitone or gabbro, which is only a diallagic variety of diabase. The true euphotide often contains a portion of talc, and sometimes encloses crystals of a triclinic feldspar, apparently labradorite, thus offering a transition to diabase. See farther my researches on Euphotide and Saussurite (*this Journal*, [2], xxvii, 339, and xxxvii, 426.)

Under the name of dolerite, as already remarked, it is proposed to class such anorthosite rocks as contain a black ferruginous pyroxene or augite. These rocks, which are sometimes coarsely granular or granitoid in their structure, pass into fine grained or compact varieties, which are distinguished by the names of anamesite and basalt. To these latter varieties belong a great part of the greenstone-traps, although in rocks of this texture it is often impossible to determine whether it is hornblende or pyroxene which is mingled with the feldspar. Olivine in grains or crystals frequently occurs both in the fine grained basaltic dolerites and in the granitoid varieties, giving rise by its predominance to what is called peridotite.' Some fine grained dolerites are porphyritic from the presence of black cleavable augite crystals, forming an augite-porphyry. Finely disseminated carbonates of lime and oxyd of iron are occasionally present in these rocks to the extent of twenty per cent, and even more. In like manner, magnetite and ilmenite, which are often associated, may constitute several hundredths of the mass. Many fine grained greenstones contain, like phonolite, large portions of some zeolitic mineral, and they often abound in chlorite. The pyroxene in these rocks is sometimes replaced by a highly basic silicate. Some varieties of what has been called diallage may be represented as an aluminiferous pyroxene *plus* a hydrate of magnesia. At other times a mineral approaching in composition to a ferruginous chlorite (frequently amorphous) enters into the composition of these anorthosites, and even in some cases appears to replace altogether the pyroxene or hornblende, constituting an aberrant form of diorite or of diabase, which is not uncommon among greenstones, and for which a distinctive name is needed. See on this point *Geology of Canada*, pp. 469, 605, and the remarks on melaphyre below.

The finer grained dolerites are often cellular, giving rise to amygdaloids, whose cavities are generally filled with calcite,

quartz, or some zeolitic minerals. To these amygdaloids the name of spilite is sometimes given. Earthy varieties of basalt, which are frequently the result of partial decomposition, constitute the wacke of some writers. It is doubtful how far many of these spilites and wackes have a claim to be considered as crystalline rocks, inasmuch as they appear in very many cases to be nothing more than aqueous sediments accumulated under ordinary conditions, or perhaps in some cases derived from volcanic ash or volcanic mud. As the other extreme of this series of rocks we may notice that dolerites often assume a trachytic form —the trachy-dolerites already mentioned—or constitute the lavas from modern volcanos.

Among the compound rocks which are related to the preceding group by the presence of augite may be noticed nepheline-dolerite, in which nepheline replaces the feldspar; and analcimite, a variety into which analcime enters in large amount. Scapolite also in some cases replaces feldspar, and forms with green pyroxene, a peculiar aggregate associated with the Laurentian limestones. Leucite enters as an important element in some dolerites, and even replaces wholly the feldspathic element, giving rise to what has been called leucitophyre or leucilite.

[Leucite is generally regarded as an exclusively volcanic mineral, but according to Fournet, it occurs like other feldspars in mineral veins, forming the gangue of certain auriferous veins in Mexico, (*Géologie Lyonnaise*, p. 261). According to Scheerer leucite also occurs in drusy cavities with zeolites and quartz at Arendal in Norway; although it would seem to be rare in this locality since Durocher was not able to detect it, (*Annales des Mines*, [4], i, 218). The conditions required for the formation of this feldspathide must be peculiar, since the volcanic rocks which afford it are confined to a few localities; and since while it contains a large amount of potash it is a basic silicate, and found among highly basic rocks, in which potash compounds are generally present only in very small quantities. The agalmatolite rocks, including dysyntribite and parophite, (*Geology of Canada*, p. 484,) are however basic aluminous silicates in which potash predominates, and might be supposed under certain conditions of metamorphism to yield leucitic rocks.]

The name of melaphyre, which is employed by many writers on lithology requires a notice in this connection. It was proposed by Brongniart as a synonym for black porphyry, (melaporphyre,) and defined by him in 1827 as a porphyry holding crystals of feldspar in a base "of black petrosiliceous hornblende." (*Classif. des Roches*, p. 106.) Subsequent researches showed that some of these porphyries were really augitic; and Von Buch employed the name of melaphyre as synonymous with augite-porphyry, in which he was followed by D'Halloy,

(*Des Roches*, p. 75). In consequence of this confusion, and of the vague manner in which the term is used to include rocks which are sometimes diorites and sometimes varieties of dolerite or basalt, Cotta seems disposed to reject the name of melaphyre as a useless synonym, in which I agree with him. (*Gesteinslehre*, p. 48.) More recently however, Senft (*Die Felsarten*, p. 263,) has endeavored to give a new signification to the term, and defines melaphyre as a reddish-gray or greenish-brown colored rock, passing into black, and containing neither hornblende nor pyroxene. The melaphyres of Thuringia and of the Hartz, according to him, consist of labradorite with iron-chlorite, (delessite,) carbonates of iron and lime, and a considerable portion of titaniferous magnetic iron. Hornblende and mica are present only as rare and accidental minerals. We have already alluded to this class of anorthosite rocks, as requiring a distinctive name, but from the historical relations of the word melaphyre, it seems to be an unfortunate appellation for rocks which are not black in color, and from which both hornblende and pyroxene are absent.

We now come to consider that third group of silicated rocks, in which the feldspathides are replaced by the denser double silicates of the grenatide family, garnet, epidote, zoisite, and perhaps idocrase. Red garnet enters into many gneissic rocks, and even forms with a little admixture of quartz, rock masses. In some of these, as in the Laurentian series, there appears an admixture of pyroxene, forming a passage into omphazite or eclogite; which consists of smaragdite (pyroxene) and red garnet, sometimes mixed with mica, quartz and kyanite, and passes through an increase of the latter into disthenite or kyanite rock. An aggregate of hornblende and red garnet forms a bed in the Green Mountains, and an admixture of red garnet with lievrite and a little mica makes up a rock in the Laurentian series. This is evidently related to eulysite, a rock forming strata in gneiss in Sweden, and consisting of garnet, pyroxene, and a mineral having the composition of an olivine in which the greater part of the magnesia is replaced by ferrous and manganous oxyds. Related to this is an apparently undescribed rock from the Tyrol, of which a specimen is before me, consisting of red garnet, green pyroxene and yellowish-green olivine, the latter greatly predominating; and also a coarsely crystalline rock from Central France, recently described by the name of cameleonite, and composed of olivine, with pyroxene, and enstatite, a magnesian augite; these minerals being accompanied by spinel, sphene and ilmenite. I have already alluded to the true euphotides, in which a compact zoisite, (jade or saussurite,) takes the place of feldspar in a rock the other element of which is pyroxene, and have shown how the occasional presence of a triclinic feldspar connects euphotide with diabase. (*This Journal*, [2], xxvii, 336.) In

the same paper are described rocks made up of a white compact garnet, with and without hornblende and feldspar, and also an epidosite, composed of epidote and quartz.

By the disappearance of the aluminous silicate from the rocks of the second and third groups, a passage is established to the amphibolites and pyroxenites, and these, through diallage rock, offer a transition to the ophiolites or serpentines. These relations are well exhibited in Eastern Canada, where the diorites or greenstones, which are sometimes highly feldspathic, pass into actinolite rock and hornblende slate on the one hand, and into diallagic diabase and diallagic ophiolite on the other.

These greenstones, which contain a chloritic mineral, and are often epidotic, pass gradually into compact or schistose chloritic rocks, frequently enclosing nodules or layers of epidote, either pure or mingled with quartz. The relations between these various rocks are such that after a prolonged study of them I find it difficult to resist the conclusion that the whole series, from diorites, diallages and serpentines, to chlorites, epidosites and steatites has been formed under similar conditions, and that they are all indigenous rocks. (*Geology of Canada*, pp. 606, 612, 652.) I have elsewhere expressed the opinion that these silicates are probably of chemical origin, and have been deposited from solutions at the earth's surface. The sepiolite or hydrous silicate of magnesia, which occurs in beds in tertiary rocks, the neolite of Scheerer, the silicates of lime, magnesia and iron-oxyd deposited during the evaporation of many natural waters; and the silicates of alumina like halloysite, allophane and collyrite, and that deposited by the thermal waters of Plombières, all show the formation and deposition at the earth's surface of silicates, whose subsequent alteration has probably given rise to many minerals and rocks. (*This Journal*, [2], xxxii, 286; and *Geology of Canada*, pp. 559, 577, 581). At the same time the phenomena of local metamorphism furnish evidences that similar compounds have resulted from the action of heat upon mechanical mixtures in sedimentary deposits, (*ibid.* p. 581). A further consideration of this subject, and of the two-fold origin of many siliceous minerals is reserved for another place.

[To be continued.]

SCIENTIFIC INTELLIGENCE.

I. PHYSICS.

1. *On the passage of radiant heat through polished, rough, and smoked rock-salt, and on the diffusion of rays of heat.*—H. KNOBLAUCH has contributed a very elaborate and valuable investigation of the transmission of radiant heat through rock-salt. We give the results in the author's own words, referring the reader for details of apparatus and methods to the original memoir.

I. (1.) Clear chemically pure rock-salt permits rays of heat of all kinds to pass through it in equal proportion, whether the difference between the rays depends upon the fact

a. that they are diffusely reflected from different bodies, or

b. transmitted through different diathermanous bodies, or

c. radiated from different sources of heat.

(2.) In the case of this absorption, equally exercised upon all elementary rays, it is proved that in the solar spectrum of a rock-salt prism the maximum of heat falls in the dark space beyond the red; within the visible portion of the spectrum the distribution of heat is the same in the case of prisms of rock-salt and flint glass.

II. (1.) The heat rays of the sun pass through rough as well as cloudy rock-salt in a less proportion than those of an Argand lamp, and these last, as a rule, in a less proportion than the rays of a source of heat at 100° C.

An increase of roughness diminishes the transmission of every kind of heat but affects solar heat most, that of a lamp less, and that of a dark source least of all.

(2.) Independently of the elective absorption exerted by the substance, the rough surface of unpolished glasses exercises an influence corresponding to that of the internal cloudiness in milky glasses.

(3.) These phenomena can not be referred (with Forbes) to an absorption which affects qualitatively different rays of heat unequally, nor (with Melloni) to an unequal dispersion in the rough and cloudy media depending on the heat-color, by which the rays are more or less deviated from the thermoscope. Neither is the roughness of the surface in itself, nor the direction of the rays proceeding from a single point the determining condition.

(4.) The diffuse heat arising from radiation through rough or cloudy screens or reflection from rough surfaces radiates more abundantly through diffusing screens according as (*a*) the rays are more diffuse, (*b*) in comparison with parallel rays, as the screens are more diffusive.

(5.) In fact the really determining condition of the passage through these screens is whether the incident rays are parallel, or more or less variously radiated from a greater or less number of points.

(6.) Hence, for one and the same source of heat, the ratio of transmission in question (in spite of a constant quantity of heat falling directly upon the plates) diminishes with the distance of the source, and the more rapidly the more diffusive the screen.

(7.) It is possible, by a proper arrangement of the experiments, to cause the more abundant passage of rays of heat from a source at 100° C. in comparison with those from the lamp, cited in (1.), to disap-

pear, and even, conversely, to bring about a more abundant transmission of the heat of the lamp.

III. (1.) In the passage of radiant heat through rock-salt covered with soot an elective absorption (suspected by Melloni) takes place without diffusion. A diffusive action (supposed by Forbes) never takes place in consequence of the rough surface of the layer of soot, but sometimes in consequence of a tarnishing of the rock-salt plate in the process of covering with soot.

(2.) In the case of transmission through thin layers of metal laid upon glass the first process takes place without the last.

(3.) The presence of an elective absorption exerted during transmission is most certainly recognized by determining whether the heat before and after its passage through the substance in question retains unchanged or varies its capacity to pass through other (clear) diathermanous bodies with a smooth surface.

(4.) A diffusive action is best tested by either of the following methods.

a. If solar heat be allowed to pass through the screen in question, and the transmitted be compared with the direct rays, either both groups of rays exhibit an equal power of transmission through colorless rock-salt, or else the first passes more freely than the second group. In this last case the plate investigated is diffusive.

b. When, of two groups of rays of the same thermic color, one of which consists of parallel and the other of diffusive rays, the latter passes most easily through the substance tested, this substance is diffusive. In this process a method is pointed out for the comparison with each other of different degrees of diffusion within very wide limits.

IV. (1.) *a.* By diminishing the angle which the rays of heat form with an unpolished or cloudy plate the diffusion exerted upon them is in general increased. This increase, with the change in inclination, in the first place becomes larger with the generally diffusive property of the screen, but then again grows less to such a degree that in very rough and sufficiently cloudy plates, just as in the case of clear ones no difference can be detected in the behavior of rays which are transmitted at different angles of inclination.

b. A diffusion produced by reflection from rough surfaces diminishes, on the contrary, for the more obliquely incident rays, and passes finally into regular reflection.

(2.) Between the smooth and the two-sided rough surface there are circumstances, in consequence of which, independently of every process in the interior of the substance, the simple mechanical quality of the surface produces a "coloration" of the transmitted heat.

(3.) It follows, therefore, that in the case of the rough and cloudy media in question, a distinction must be made between the action of the diffusion, which is always present, and that of the elective absorption which sometimes occurs.

(4.) Fused common salt produced a diffusion but no heat-coloration.

(5.) Another piece of rock-salt was found to be chemically and mechanically impure, and exercised both a diffusive action and an elective absorption. Circumstances of this kind explain the varying observations made in different experiments with rock-salt.—*Pogg. Ann.*, cxx, 177.

W. G.

II. CHEMISTRY.

1. *On a cyanid of phosphorus.*—HÜBNER and WEHRHANE have described a tercyanid of phosphorus obtained by the following process. Perfectly dry cyanid of silver is heated in a glass tube with an equivalent quantity of terchlorid of phosphorus diluted with chloroform. The double decomposition requires a temperature of 120° C. to 140° C. for several hours. The chloroform is distilled off in a current of carbonic acid gas and the cyanid of phosphorus sublimed into the neck of the retort. Tercyanid of phosphorus forms long brilliant snow-white crystals. When gently heated they take fire in the air and burn with a bright light. Water decomposes the cyanid with violence, forming phosphorous and cyanhydric acids. The crystals melt and volatilize at about 190° C. Analysis proved that the constitution of the cyanid of phosphorus is PCy_3; the authors propose to study the products of its decomposition.—*Ann. der Chemie und Pharm.*, cxxviii, 254, Nov. 1863. W. G.

2. *On Indium.*—REICH and RICHTER have given some further details of the new metallic element, Indium, discovered by them in the Freiburg blendes. Indium gives in the spectroscope two blue lines, of which the brighter stands at 98, the fainter at 135, of a scale on which the sodium line stands at 38, and the blue strontium line at 93. A compound of indium colors the flame of Bunsen's burner violet, so that the presence of the metal may be detected without the spectroscope. The metal as obtained by reducing the oxyd before the blowpipe on charcoal with soda is soft and ductile, leaving on paper a streak which is brighter than that of lead and somewhat like that of tin. The metal dissolves in chlorhydric acid with evolution of gas, and the solution gives the blue line with great intensity. The hydrated oxyd precipitated by ammonia is white and shiny: tartaric acid prevents its precipitation by ammonia, but sulphid of ammonium produces in this solution a voluminous white precipitate. Potash behaves like ammonia; carbonate of soda precipitates a white crystalline carbonate. The oxyd ignited in a current of hydrogen gave no water and remained unchanged. Heated with carbon in a current of chlorine the oxyd yields a very volatile chlorid condensing in colorless crystalline leaves with the lustre of mother-of-pearl. This chlorid deliquesces readily, and on drying is partially decomposed. The chlorid gives the blue line in the spectroscope with great intensity, but in this case the duration of the line is very short. It is better to heat the oxyd in a platinum spoon with a little chlorhydric acid, when the blue line is rather less brilliant but lasts longer. A solution of the metal in chlorhydric acid gives with ammonia and sulphid of ammonium a grayish brown precipitate, but it is possible that the color may arise from impurities. The separation of iron from indium is difficult. The chlorid gave with ferrocyanid of potassium a white precipitate, with a shade of blue from the presence of iron, ferridcyanid gave no precipitate, sulphocyanid of potassium a pale red, owing to the presence of iron. The oxyd gives no blue color before the blowpipe with cobalt solution, and after ignition dissolves slowly but completely in chlorhydric acid. The authors satisfied themselves that indium occurs only in the Freiberg zincblende, and not in the arsenkies and schwefelkies.—*Journ. für prakt. Chemie*, Band 90, 172. W. G.

III. MINERALOGY AND GEOLOGY.

1. *Eusynchite and Dechenite.*—In an extended investigation on Vanadium, C. Czudnowicz reviews the analyses of *vanadinite*, *dechenite*, *araoxene* and *eusynchite*. He shows, that the method used by *Tschermak* for the indirect determination of vanadic acid, in the *rhombic vanadinite* from Kappel in Carinthia, is incorrect, and the conclusion that the mineral was a simple vanadate of lead, $\dot{P}b\dddot{V}$, is an assumption not justified by the facts: the only datum for this, being a single determination of the per-centage of lead. Czudnowicz gives the following new analyses of *eusynchite:*

	$\dot{P}b$	$\dot{Z}n$	$\dddot{V}$*	$\ddot{S}i$	$\dot{P}$		
1.	56·47	16·78	23·55	3·20	*traces*	=	100
2.	53·91	21·41	19·17	5·51	*traces*	=	100

* By loss.

From these results it appears that eusynchite is a ter-basic vanadate of lead and zinc, with the formula $(\dot{P}b, \dot{Z}n)^3\dddot{V}$. Czudnowicz calls attention to the analogy between *eusynchite*, *aræoxene* and *dechenite*, and suggests that the latter may contain zinc, the presence of which might have been overlooked, as was the case in Nessler's analysis of eusynchite.—(*Pogg. Ann.*, cxx, 17.)

[In a note to Nessler's analysis of eusynchite, published in the 4th Supplement to Dana's Mineralogy (*this Journal*, [2], xxiv, 116, July 1857), I stated that, on qualitative analysis of this mineral, I had found it to contain zinc, and attention was also called to its remarkable resemblance to dechenite. This statement is now confirmed by the analyses of Czudnowicz, although he has overlooked my observations on eusynchite, as also the fact that in the same article I pointed out the existence of zinc in dechenite, and suggested the probability that dechenite and aræoxene were identical. About the time my note was published, Bergemann gave the following analysis of aræoxene in Leonhard and Bronn's *Jahrbuch für Mineralogie* (1857, p. 397):

$\dot{P}b$	$\dot{Z}n$	$\dddot{\dot{A}}s$	$\dddot{V}$	$\ddot{\bar{A}}l\ddot{\bar{F}}e$*		
52·55	18·11	10·52	16·81	1·34	=	99·33

* With traces of phosphoric acid.

Bergemann mentions that aræoxene and dechenite occur together at Dahn, in the Palatinate, but that dechenite may be distinguished from aræoxene by the color, the former being a beautiful red, while the latter is reddish-brown to deep brown. In the original analyses of dechenite by Bergemann, he found in the dark red crystalline variety, in two determinations, 52·92 and 53·72 p. c. of oxyd of lead, and in the yellowish variety 50·57 p. c. of oxyd of lead. In some specimens, he obtained on charcoal a reaction for arsenic, although, he says, the pure specimens contained no arsenic. It would seem then, that Bergemann considers aræoxene and dechenite distinct mineral species; he, however, gives us no new examination of dechenite, but merely re-asserts that dechenite is a neutral vanadate of lead. I have examined a specimen of dechenite obtained from Dr. Krantz in 1851, shortly after Krantz and Bergemann had described this species, and have found that it contains, not only *zinc*, but *arsenic*. The specimen has the appearance of being pure and unaltered; it is perfectly homogeneous, has a brownish-red color, is botryoidal

n form, and, under the lens, its structure appears crystalline. There is every probability that this specimen, which Dr. Krantz, the discoverer of the species, called dechenite, has the same composition as aræoxene. It is worthy of note, that the method used by Bergemann for the quantitative determination of vanadic acid, would not separate it from arsenic acid and oxyd of zinc, had such been present. Further, it is suggested by Czudnowicz, that the fact that Bergemann was unable to separate sulphuric acid from the so-called pure vanadic acid by heat, indicated the presence of a base with the vanadic acid, as it is well known, and fully established by the observations of Fritzsche and Schafarik, that there is no difficulty whatever in effecting this separation. It is also a somewhat singular coincidence that dechenite, if it be a neutral vanadate, should happen to have the same percentage of oxyd of lead as the terbasic vanadate aræoxene. It is further somewhat peculiar, if they are distinct species, that their specific gravity should be so nearly identical: dechenite having a density of 5·81, while that of aræoxene is 5·79. The same may be said of their hardness and the other physical characters, except a questionable difference in color. Any one reading v. Kobell's description of aræoxene[1] and Bergemann's original description of the physical characters of dechenite[2] could hardly fail to conclude that they are the same mineral. To all this, adding the fact that Dr. Krantz, the discoverer of dechenite, considers the two minerals to be identical, and further, that a specimen of the so-called pure dechenite, received from Dr. Krantz, as early as 1851, proves to have all the characters of aræoxene, we think we may safely question the accuracy of Bergemann's results in his examination of dechenite. Czudnowicz calls especial attention to the circumstance that all the native vanadates thus far described, of which we have trustworthy analyses, are basic in their character.—G. J. B.]

2. *Göthite from Lake Superior.*—This mineral is found associated with hematite at the Jackson Iron Mountain, near Marquette, Lake Superior. Some of the specimens have the hyacinth-red color which characterizes the variety of göthite called by the Germans "Rubinglimmer." It also occurs in acicular crystals of an almost velvet-black color and lustre, and it is occasionally found in distinct trimetric crystals. A determination of the water gave 10·47 p. c. G. J. B.

3. *Szaibelyite.*—This new borate, described by Peters and already noticed briefly in this Journal,[3] has been further investigated by Stromeyer and Peters.[4] It occurs disseminated through a gray granular limestone at Werksthal near Retzbanya. This limestone, treated with dilute nitric acid in the cold, gave a residue consisting of a crystalline powder, and also rounded kernels of the size of a lentil. These kernels are translucent, white on the exterior, and interiorly yellowish. Hardness, between 3 and 4. Stromeyer found the limestone to contain 16·6 of crystalline needles, and 14·8 of the rounded kernels. The specific gravity of the former was 2·7, of the latter 3·0. The air-dried mineral was constant in weight at 100° C. Analysis of the two varieties gave:

	$\dddot{\mathrm{B}}$	$\dot{\mathrm{M}}\mathrm{g}$	$\dddot{\mathrm{F}}\mathrm{e}$	$\dot{\mathrm{H}}$	Cl	Quartz.		
1. Needles,	36·66	52·49	1·66	6·99	0·49	0·20	=	98·49
2. Kernels,	34·60	49·44	3·20	12·37	0·20	——	=	99·81

[1] Jour. prakt. Chem., l, 496.
[2] Pogg. Ann., lxxx, 393.
[3] Vol. xxxiv, p. 221.
[4] Ber. Wien. Akad., xlvii, 348.

The needles contained traces of carbon, and oxyd of manganese. If the chlorine is considered to exist as MgCl and the iron as $\ddot{F}e^2\dot{H}^3$, and these with the 0·20 quartz be subtracted from No. 1, and averaged to 100, the composition of the mineral will be $\dddot{B}$ 38·35, $\dot{M}g$ 54·65, $\dot{H}$ 7·00=100. This gives the formula $3(\dot{M}g^5\dddot{B}^2)+4HO$. A similar calculation made with No. 2 gives $\dddot{B}$ 36·18, $\dot{M}g$ 51·52, $\dot{H}$ 12·35=100, and the formula $3(\dot{M}g^5\dddot{B}^2)+8\dot{H}$, or 4 atoms more of water than the crystalline variety. The composition is related to that of stassfurthite, this last mineral being an acid hydroborate combined with chlorid of magnesium, while szaibelyite is a basic hydro-borate in which chlorid of magnesium is not an essential constituent. [The specific gravity of the borate with 4 atoms of water is stated to be less than that with 8 atoms of water, this is probably either a misprint or an error in observation.—G. J. B.]

4. *Astrophyllite.*—F. Pisani has reëxamined Scheerer's astrophyllite. It is a micaceous substance, found at Brevig imbedded in a feldspar of the zircon-syenite, and is associated with catapleiite, ægirine, and large prisms of a black mica. It forms six-sided prisms, frequently lengthened in the direction of the shorter diagonal, sometimes in stellated groups and having a basic cleavage. In thin leaves translucent. Color bronze-yellow. The powder resembles mosaic gold. Laminæ only slightly elastic. H.=3. G.=3·324. Before the blowpipe swells up, and fuses easily to a black magnetic enamel. With soda and borax shows a strong manganese reaction. In the spectroscope gives the lines of lime, soda, potash, and lithia. Decomposed by chlorhydric acid with separation of silicic acid in scales; the solution heated with zinc or tin gives the reaction for titanic acid. Analysis gave—silica 33·23, titanic acid 7·09, zirconia 4·97, alumina 4·00, ferric oxyd 3·75, ferrous oxyd 23·58, manganous oxyd 9·90, lime 1·13, magnesia 1·27, potash 5·82, soda 2·51, lithia *trace*, ignition 1·86=99·11. The oxygen ratio of the bases to the acid, considering the titanium and zirconium to be sesquioxyds and basic, is as 16·87 to 17·72, which would indicate that this species belonged to the mica group of minerals. The small amount of alumina in the mineral is singular.—*Jour. f. prakt. Chem.*, xc, 53, from *Comptes Rendus*, lvi, 846. G. J. B.

5. *Bragite.*—J. A. Michaelson has analyzed a columbate from Helle in Norway, which he says is the *bragite* of Forbes and Dahl. The mineral is grayish-brown in color, has an uneven fracture and a metallic lustre. H.=4·5. G.=5·40. With salt of phosphorus and borax gives a bead, which is greenish-yellow while warm, and colorless on cooling. Composition:

$\dddot{C}b$	$\ddot{Z}r$	$\dot{Y}$	$\dot{C}e$	$\ddot{U}$	$\dot{F}e$	$\dot{M}n$	$\dot{C}a$	$\dot{M}g$	$\dot{P}b$	$\dot{H}$
48·19	1·45	32·71	7·43	4·95	1·37	0·11	1·82	0·39	0·09	1·03

from which Michaelson draws the formula $\dot{R}\dddot{C}b$, and considers the mineral to be identical with tyrite and fergusonite.—*J. f. pr. Chem.*, xc, 108. [Tyrite and fergusonite need further investigation; it may be that bragite and tyrite are identical, but the analyses of Hartwell, Weber and Forbes would indicate that fergusonite and tyrite are distinct species.—G. J. B.]

6. *On Organic Remains in the Laurentian Rocks of Canada;* (from a letter to the Editors of this Journal from Sir W. E. Logan, F.R.S., dated Montreal, Feb. 17th, 1864.)—In August, 1859, I exhibited to the

American Association at Springfield, Mass., specimens of what was regarded by me as an organic form externally resembling *Stromatocerium*, and found in the Laurentian limestone of the Ottawa. These were described by me in the *Canadian Naturalist* for that year, (vol. iv, p. 300,) and afterwards figured in the *Geology of Canada*, (p. 49). In 1863, similar forms were detected by the Geological Survey, in the serpentine-limestone of Grenville, sections of which we have prepared and submitted for microscopic examination to Dr. J. W. Dawson. He finds that the serpentine, which was supposed to replace the organic form, really fills the interspaces of the calcareous fossil. This exhibits in some parts a well-preserved organic structure, which Dr. Dawson describes as that of a Foraminifer "growing in large sessile patches after the manner of *Carpenteria*, but of much greater dimensions, and presenting minute points which reveal a structure resembling that of other foraminiferous forms, as for example *Calcarina* and *Nummulites*." Figures and descriptions will soon be published by the Geological Survey.

Large portions of the Laurentian limestones appear to be made up of fragments of these organisms, mixed with other fragments which suggest comparisons with crinoids and other calcareous fossils, but cannot be distinctly determined. Some of the limestones are more or less colored by carbonaceous matter, which Dr. Dawson, has found to exhibit under the microscope evidences of organic structure, probably vegetable.

In this connection it may be noticed that Mr. Sterry Hunt, in a paper presented to the Geological Society of London, in 1858, (see also *this Journal*, [2], xxxi, 296.) insisted upon the presence of beds of iron-ore, metallic sulphurets and graphite, in the Laurentian series as "affording evidence of the existence of organic life at the time of the deposition of these old crystalline rocks."

It was stated in the *Geology of Canada*, p. 839, (and also in *this Journal*, [2], xxxvi, 223,) that these oldest known stratified rocks, constituting the great Laurentian system, are probably to be divided into two unconformable groups. Subsequent examinations during the past year have furnished additional evidence that what we have called the Labrador series rests unconformably upon the true Laurentian series. It is the limestones of this latter and more ancient division which have afforded the Foraminifera noticed above.

7. *On Glaciers and other phenomena connected with the Himalayas;* (Proc. Roy. Geog. Soc., Jan. 1864.)—Dr. Falconer, after describing the progress of the Trigonometrical Survey in India, next drew attention to the glacier system of the Himalayas. All the best observers—Dr. Thomson, Jacquemont and others—had been of opinion that there was but one great system of mountains. There was no such thing as any break of mountain-range, or any distinct mountain-chains. There were great rivers which cut them across, rivers like the Indus, the Sutlej, and some feeders of the Ganges; but, regarded in one grand aspect, they constituted a series of mountains with ravines and valleys intervening. Viewed, then, in this light, there were two great ranges which culminated to especially great altitudes, and which bounded the Indus river to the south and to the north; and this being one of the points where the Himalayan chain attained its greatest altitude, there the glacial phenomena were developed in the greatest grandeur and upon the loftiest scale. The paper

referred to that part of the range which bounded the valley of the Indus upon the north, the Kara-Korum, or Mooz-tagh, or the "Icy range of mountains," and the other great series of them were the mountains which bounded the Indus upon the south. Although the glaciers upon the Shigar valley and in the valley of Bialdoh, which he himself had visited in 1838, were of such surpassing grandeur and importance, as had been mentioned by Sir Roderick Murchison, it was but fair to say that upon the northern side there were glaciers which, so far as description went, were equally grand, if not grander. Those to which he should especially refer were the glaciers at the head of the Zanscar river. Mr. J. A. Arrowsmith was well acquainted with the mountain-ridge to which he referred and the glaciers which arose from it. There was a river called the Chenab, and a mountain-range which stretched across between the Indus and the Chenab. The pass of the dividing ridge at this point was 18,000 feet above the level of the sea; and upon either side, but more especially upon the north, at the head of the Zanscar river, were some of the grandest glacier phenomena to be seen in any part of the world. There were glaciers extending from a very great distance, and having enormous width, and which, until the description that had been given by Capt. Austen, had been unrivalled by any glacial phenomena with which they were acquainted, except the glacial formations in the Arctic regions.

With regard to the glaciers upon the north, the Indus ran through a flat country westward, receiving from the north three great branches; the first branch, called Sha-Yuk, from the Kara-Korum, next the Nubra river, and also the Shigar, which was the especial object of Capt. Godwin-Austen's communication. Now, the Shigar valley was the third of importance of all the affluents of the Indus, and was bounded by mountains of great elevation. Some of them which had been measured by Captain Montgomery attained a very great elevation; one a height of 28,000 feet above the level of the sea. This naturally entailed a prodigious amount of condensation of the moisture of the atmosphere, and led to a very heavy fall of snow, the consequence of which was great glacial phenomena. Twenty-seven years ago he had been up to Arindoh, the extreme termination of the western or Basha branch, and from that point he got across upon the other valley by the Scora-là Pass to the glacier of the Bialdoh river, where he saw all the phenomena which had been described by Capt. Godwin-Austen. Having premised this much with regard to special details, there were one or two points which he was desirous to bring before them. One was, What were the peculiar characteristics of the Himalayan mountains, as well as of all tropical mountains, as compared with our European mountains? There was one characteristic of the Himalayan chain so remarkable that he should take the liberty of explaining it. He presumed that most of his audience had visited either the northern or southern side of the Alps; and those who had been in the plains of Italy, along the valley of the Po, were well acquainted with the numerous lakes which jutted out from the Alps into the plain of Italy. Commencing on the west there were the Lago d'Orta, the Lago Maggiore, the Lago di Lugano, the Lago di Como, the Lago d'Iseo, and the Lago di Garda; in fact, wherever a great valley projected itself from the chain of the Alps at right angles to the strike of the chain, there was, with one exception, a great lake. Regarding these lakes in a general way, without

reference to detailed phenomena, they found one thing which was constant about them—"they were invariably narrow, and some forty or fifty miles long, as notably in the case of Maggiore, Como, and Garda." The next remarkable thing about them was that they invariably radiated out at right angles to the strike of the great chain of the Alps. The Alps made a curve from the Pennine round to the Rhetian Alps. They would also observe that those lakes were severally fed by a great river which proceeded from a high ridge of the chain, and which was thrown forward into the plains of the valley of the Po. If they would regard the Himalayan mountains, or any tropical range of mountains whatever, in a similar way, they would find that these phenomena were invariably wanting. Great rivers, like the Indus, the Chenab, the Sutlej and the Ganges, which passed through the Himalayan mountains and debouched into the plains of India, had valleys of infinitely greater importance than the valleys either to the north or south of the Alps; but they were never connected with a lake.

The question then arose, What was the physical reason of this great difference between the tropical mountains and those of temperate Europe? Nearly thirty years ago, he was for ten or twelve years rambling about the Himalayan mountains along a stretch of 800 miles, and he used to open a map before him, and try to make out the comparative features of European and Eastern mountains. He looked to the numerous lakes to the north and south of the Alps; and he would put the map of India alongside, where the same kind of rivers were debouching into the plains, but where there was an utter absence of the lakes; and he used to puzzle himself in trying to discover a physical explanation of this difference. He was perfectly satisfied there must be some secondary conditions which were not common to the two. * * * There was the same kind of elevation above the level of the sea, the same kind of valleys, the same kind of fissures intersecting the valleys.—What then was the explanation? This he would endeavor to indicate. About two years ago, as his friend Sir Roderick Murchison was aware, a paper was brought before the Geological Society of London, by Professor Ramsay, which excited a great deal of attention, and gave rise to a very animated discussion.[1] The theory of the paper was that, as a general rule, lakes in all the temperate and cold regions of the world were the product of glacial excavation; that is to say, that, wherever a glacier came down from a high ridge of mountains into a plain, it ploughed its way down from the solid rocks and carved out a great lake. This was the theory, or rather hypothesis, which Professor Ramsay put forward to explain the lakes which were so abundant in the valleys of the Alps. A similar speculation, but greatly more restricted, had been advanced by Martillet a short time before. He limited the action of the glacier to scouring out the silt of the filled up lake-basins, the origin of which he attributed to antecedent fissures, the result of upheaval. An application of this theory was made to the different physical phenomena which were connected with the case; and it occurred to himself and many others (and he believed Sir Roderick had an opinion in common with himself) that it was not adequate to explain the phenomena; and on the occasion when it was produced, he met it with the most lively opposition in connection with his own experience in the Himalayan mountains. The opposition which he gave to it was

[1] See this Journal, [2], xxxv, 324–345, May, 1863.

upon these grounds. Many of them would remember that the lakes Maggiore and Como were upon the edge of the plains of Italy; that the glaciers—say that of the Ticino, which came down into the Lago Maggiore—came down along a steep incline, and was at last delivered into that lake, which was about fifty miles long, and only eight or nine miles wide at its widest point. Its prolongation nearest to the Mediterranean attained a depth of about 2600 feet below the level of the sea; that is to say, it attained a depth of half a mile below the sea-level. Where the river escaped out of the lake it was not more than 600 feet above the level of the sea. It was a remarkable point in the case that this glacier by the hypothesis should have ploughed its way down and actually dived into the bowels of the earth 2000 feet below the level of the Mediterranean, and then should have again risen up along an incline at a rate of about 180 feet per mile. Without going into all the objections, he might state he believed the principal one was, that the mechanical difficulties in the case were entirely left out of sight by the supporters of that theory; and on that occasion, after very long study of the subject, he endeavored to bring forward what occurred to him as the true explanation of the difference between the Himalayan mountains and the Alps. The difference he believed to consist in this: that, after the last upheaval of the Alps, great fissures, or basins of lakes, were left there, with rivers running into them, in the manner in which the Rhône runs into the lake of Geneva, bringing down enormous quantities of silt, which, if you give a sufficient number of ages, would have completely filled them up. But, before this was accomplished, what is called the glacial epoch commenced; that is to say, there was an enormous projection of ice and snow below the limit that they now saw it in the Alps, out into the plains, both to the north and south of that chain: and, as the snow and ice came down, they filled up those lakes and formed a bridge, upon which the moraine material was carried over, there being a certain measure of incline from the summit of the Alps down to the plains of Italy. When once the basins were filled with ice to the depth of 2500 feet, they made, as it were, a slide or incline, upon which all the solid material could be transported; and that being carried forward by the *vis motrix* of the mass, formed the large moraine which we saw at Lake Maggiore, that of the Brianza, and also the moraine which bounded Lake Garda, where the battle of Solferino was fought. This was the secondary condition that occurred in Europe. Precisely the same primary conditions occurred in the great valleys of the Himalayas, but without the same glacial phenomena. These mountains were thrown up above the level of the sea, and vast perpendicular fissures were left, forming what were at that time the basins of lakes. But in those tropical regions the ice never descended from the highest summits down into the plains of India; and, instead of being filled up by snow, which afterwards melted into water, these lake-basins were gradually silted up by enormous boulders and alluvium of every kind, which were brought down by rivers from the Himalayan mountains. The difference in the two cases was, that, whereas the ice filled up the lake-basins in the Alps, constituting, as it were, the conservative means by which those lakes were saved from being silted up by alluvial and other matters, in the Himalayan mountains this conservative action did not take place, and the lake-basins remaining open were filled up in the man-

ner mentioned. If they would look at the map of the Himalayan mountains, one of the most remarkable things they would observe on the southern side of the chain was, that there were no great lakes whatever —not one that would compare with Lake Lugano, or with any of the second or third-rate lakes in the Alps. But, if they crossed to the northern side of the chain, where the temperature was much colder during the winter, there they would find great lakes. The cold produced the same conservative action on the northern side of the Himalayas, in preventing the lakes being filled up, which it did in the Alps by restricting the silting action.

The next point was one of some interest and importance. There was a material well known in commerce and arts called borax, now largely employed in ceramic products. It used to be got only from India as an export from Thibet, and it was invariably found in connection with hot springs. Within the last twenty years, a remarkable change had taken place. The late Count Larderelle, an original-minded and eminently philanthropic Frenchman, of Leghorn, aware of the presence of boracic acid in the jets of steam which are emitted from the surface of the broken soil in the ravines of Monte Cerboli, on the margin of the Maremma of the Volterra in Tuscany, hit upon the happy idea of utilizing the natural heat in lieu of fuel to effect the process of evaporation. * * * An unbounded supply of boracic acid was the result. As a consequence, the borax of Thibet fell in value from 37*l.* or 40*l.* a ton to nearly half that price, until at length borax was exported from England at the rate of 10*l.* per ton to displace the native article from the bazaars of India. In Thibet the mineral is biborate of soda, which in many places abounds in the soil: while in Italy it is boracic acid. For the best account of the Himalayan region he would refer to Dr. Thomson's 'Travels in Thibet.'

Henry Colebrook, the first who, along with Colonel Crawford, measured the heights of the Dwalagiri, procured from the plateau of Chanthan in the Himalayas, at a height of 17,000 feet above the sea-level, fossil bones, which were brought down and exported as charms into India, to which the natives attributed a supernatural origin, and called them "lightning or thunder bones." At the present time, during eight months of the year, the climate differed in no important respect from that of the Arctic circle, and in the whole of the district there was not a single tree or shrub that grew larger than a little willow about nine inches high. The grasses which grew there were limited in number, and the fodder, in the shape of dicotyledonous plants, was equally scarce. Yet, notwithstanding this scantiness of vegetation, large fossils were found of the rhinoceros, horse, buffalo, antelope, and of several Carnivores—species indicating that, at no very remote period of time, a plateau in the Himalayan mountains, now exceeding three miles above the level of the sea and Arctic in climate, had then such a climate as enabled the rhinoceros and several subtropical forms to exist. It would occupy too much time to explain the details of this complex phenomenon. He would briefly state that the only rational solution which science could suggest was that, within a comparatively modern period, a period closely trenching upon the time when man made his appearance upon the earth, the Himalayas had been elevated 8000 or 10,000 feet.

IV. BOTANY.

1. *Nomenclature.*—Tho propositions for the improvement of zoological nomenclature, made to the British Association at its twelfth meeting, in 1842, by an influential committee, are well known. They were essentially limited to zoology mainly for the reason, which is undoubtedly true, that botanical nomenclature stands in much less need of distinct enactment than zoological. At the recent New Castle meeting the committee on this subject was reconstituted, and instructed "to report on the changes which they may consider it desirable to make, if any, in the rules of nomenclature drawn up at the instance of the association by Mr. Strickland and others, with power to reprint these rules, and to correspond with foreign naturalists and others on the best means of insuring their general adoption." "Accordingly the rules, as originally circulated, are now reprinted [i. e. in the Edinburgh New Philosophical Journal for Oct. 1863, p. 260 et seq.], and zoologists are requested to examine them carefully, and to communicate any suggestions for alteration or improvement, on or before the first of June, 1864, to *Sir William Jardine, Bart., Jardine Hall, by Lockerby, N. B.*"

As most of the propositions are from their nature equally applicable to botany, and as the new committee comprises the names of four botanists, extremely well selected, it is obvious that the improvement of nomenclature of genera and species in natural history in general is contemplated. We feel free, therefore, to make any suggestions that may occur to us from the botanical point of view.

First, we would recommend that "the admirable code proposed in the *Philosophica Botanica* of Linnæus,"—to which, "if zoologists had paid more attention . . . the present attempt at reform would perhaps have been unnecessary,"—be reprinted, with indications of the rules which in the lapse of time have become inoperative, or were from the first over nice: *ex gr.* 222, 224, 225, 227, 228, 229, 230, etc., most of which are recommendations rather than laws. The British Association's Committee has properly divided its code into two parts, 1. Rules for rectifying the present nomenclature: 2. Recommendations for improving the nomenclature in future. The laws all resolve themselves into, or are consequences of the fundamental law of priority, "the only effectual and just one."

Proposing here to comment only upon the few propositions which seem to us open to doubt, we venture to suggest that the "§ 2. *The binomial nomenclature, having originated with Linnæus, the law of priority in respect of that nomenclature, is not to extend to the writings of antecedent authors,*" is perhaps somewhat too broadly stated. The essential thing done by Linnæus in the establishment of the binomial nomenclature was, that he added the specific name to the generic. He also reformed genera and generic names; but he did not pretend to be the inventor or establisher of either, at least in Botany. This merit he assigns to Tournefort, in words which we have already cited in this Journal (vol. xxv, p. 134); and he respected accordingly the genera of Tournefort, Plumier, &c., taking only the liberties which fairly pertained to him as a systematic reformer. While, therefore, it is quite out of question to

supersede established Linnæan names by Tournefortian, we think it only right that Tournefortian genera, adopted as such by Linnæus, should continue to be cited as of Tournefort. So, as did Linnæus, we prefer to write *Jasminum*, Tourn., *Circæa*, Tourn., *Rosmarinus*, Tourn., *Tamarindus*, Tourn., etc. Indeed, it is not fair to Linnæus to father upon him generic names, such as the last two and many more, which Linnæus specially objects to, as not made according to rule. Specific names, of course, cannot antedate Linnæus, even if the descriptive phrase of the elders were of a single and fit word.

"§ 10. *A name should be changed which has before been proposed for some other genus in zoology or botany, or for some other species in the same genus, when still retained for such genus or species.*" The first part of this rule is intended, we presume, to be the equivalent of No. 230 of the *Philosophia Botanica*: "*Nomina generica plantarum, cum zoologorum et Lithologorum nomenclaturis communia, si a Botanicis postea assumta, ad ipsos remittenda sunt.*" We submit that this rule, however proper in its day, is now inapplicable. Endlicher, who in a few cases endeavored to apply it, will probably be the last general writer to change generic names in botany because they are established in zoology. It is quite enough if botanists, and perhaps more than can practically be effected if zoologists, will see that the same generic name is used but once in each respective kingdom of nature.

"§ 12. *A name which has never been clearly defined in some published work should be changed for the earliest name by which the object shall have been so defined.*" Very well. And the good of science demands that unpublished descriptions, and manuscript names in collections, however public, should assert no claim as against properly published names. But suppose the author of the latter well knew of the earlier manuscript or unpublished name, and had met with it in public collections, such name being unobjectionable, may he wilfully disregard it? And as to names without characters, may not the affixing of a name to a sufficient specimen in distributed collections (a common way in botany) more surely identify the genus or species than might a brief published description? Now the remarks of the Committee, prefixed to § 12, while they state the legal rule of priority, do not state, nor in any way intimate, that a wilful disregard of unpublished names, especially of those in public or distributed collections, is injurious, dishonorable, and morally wrong. In the brotherhood of botanists, it should be added, custom and courtesy and scientific convenience in this respect have the practical force of law, the wilful violation of which would not long be tolerated; and the distribution of named specimens, where and as far as they go, is held to be tantamount to publication.

As to the recommendations for the future improvement of nomenclature, in passing under review the "Classes of objectionable names," we wonder that geographical specific names should have been objected to: we find them very convenient in botany and, next to characteristic names, about as good as any. Comparative specific names in *oides* and *inea*, etc., are much used by botanists, and are often particularly characteristic. Specific names derived from persons, used with discretion, and as far as possible restricted to those who have had to do with the species, as dis-

coverer, describer, &c., are surely unobjectionable. Generic names derived from persons are, we agree, best restricted to botany, where, when appropriately applied, they are in good taste, if not too cacophonous. As to closely resembling names, in large genera it may sometimes be best to "call a species *virens* or *virescens*" when there is already a *viridis*. Anagrams, like puns, if not cautiously handled and particularly well made, are intolerable. But what can be prettier, among unmeaning names, than R. Brown's *Tellima?* Botanists will hardly agree that a good generic name which has been effectually superseded by the law of priority, should never afterwards be bestowed upon some other genus of some other order. "It has sometimes been the practice, in subdividing an old genus, to give to the lesser genera so formed the names of their respective typical species." The Committee objects to this usage because the promotion calls for new specific names. To us it seems a natural and proper course, when the name of the species in question is substantive and otherwise fitting,—most proper when (to take a not uncommon case) one used generically in the first place by ante-Linnæan naturalists or herbalists.

But the objection of the Committee is probably connected with a peculiar view which they have adopted as to the way of citing species which have been transferred to some other than the original genus. Here many zoologists, and a few botanists, have been giving themselves much trouble and perplexity, as it seems to us, to little purpose. Take for illustration our Blue Cohosh, originally *Leontice thalictroides* of Linnæus, but afterwards, in Michaux's Flora, taken as the type of a new genus, and therefore appearing as *Caulophyllum thalictroides*. Now if we adopt the view of Linnæus, to which he would probably have adhered had he lived till now, we write the name and the authority thus:—

Leontice thalictroides, Linn.
(Syn. *Caulophyllum thalictroides*, Michx.)

The abbreviated names of the authors appended stand in place of the full reference, e. gr. Linn. Sp. Pl. 1, p. 448, and Michx. Fl. Bor.-Am. 1, p. 205, tab. 21. If the other view be adopted, it stands, in fact:—

Caulophyllum thalictroides, Michx.
(Syn. *Leontice thalictroides*, Linn.)

But, fearful lest the original describer should be robbed of his due credit, it has been proposed to write,—

Caulophyllum thalictroides, Linn. This is not only an anachronism of half a century, but an imposition upon Linnæus of a view which he had not and perhaps would not have adopted. To avoid such fatal objections, it has been proposed to write *Caulophyllum* (Michx.) *thalictroides*, Linn.; which is not only "too lengthy and inconvenient to be used with ease and rapidity," but too cumbrous and uncouth to be used at all. And finally, the Committee propose to write,—

Caulophyllum thalictroides, (Linn.) (sp.),—

which is scarcely shorter, or even to leave out the (sp.) The reader is thus to note that Linnæus originally gave the specific name *thalictroides*, but not the generic. Who did, must be otherwise ascertained. A pretty long experience convinces us that much confusion is risked or trouble expended, and nothing worth while secured by these endeavors to put for-

ward the original rather than the actual application of a specific name. Ante-Linnæan nomenclature broke down in the attempt to combine specific appellation with description. Here the attempt is to connect it with the history of its origin, which, after all, can be rightly told only in the synonymy. The natural remedy for the supposed evil which this mode of citation was to cure is, to consider (as is simply the fact) that the appended authority does not indicate the origin, but only the application at the time being, of the particular name, and so no one is thus robbed of his due. The instructed naturalist very well knows the bibliography of species, or where to look for it; the tyro can learn.

"§ C. *Specific names should always be written with a small initial letter, even when derived from persons or places:*"—on the ground that proper names written with a capital letter are liable to be mistaken for generic. (But no naturalist would be apt to write the name of a species without that of the genus, or its initial, preceding.) Also, "that all species are *equal*, and should therefore be written all *alike*." The question is one of convenience, taste, and usage. As to the first, we do not think a strong case is made out. If mere uniformity be the leading consideration, it might be well to follow the example of the American author who corrected *Ranunculus Flammula* Linn. and *R. Cymbalaria* Pursh, into *R. flammulus* and *R. cymbalarius!* As to taste and usage, we suppose there would be a vast preponderance against the innovation, so far as respects personal names and those substantive names which Linnæus delighted to gather from the old herbalists, &c., and turn to specific use, e. g., *Ranunculus Flammula*, *R. Lingua*, *R. Thora*, *R. Ficaria*, and the like. Adjective names of places and countries, Linnæus printed with a small initial, e. g., *R. lapponicus*, etc. DeCandolle writes such names with a capital letter; and this best accords with English analogy, but has not been universally adopted, and probably will not be.

"§ F. *It is recommended that in subdividing an old genus in future, the names given to the subdivisions should agree in gender with that of the original group.*" The practical objection to this is, that old names should be revived for these genera or subgenera, if there be any applicable ones, which is likely to be the case in botany. A. G.

2. *Annales Musei Botanici Lugduno-Batavi*, edidit F. A. Guil. Miquel. Univ. Rheno-Trajec. Bot. Prof., Musei Bot. L. B. Director. Tom. I, fasc. 1–4, pp. 1–128, tab. 1–4, fol. Amsterdam and Utrecht. 1863.—Professor Miquel, still retaining his chair at the University of Utrecht, has succeeded the late Dr. Blume as Director of the Royal Botanical Museum at Leyden; and that institution, where invaluable materials have been for many years accumulating, already begins to show the effects of his activity and good judgment. Four numbers of the present work, each of eight folio sheets of letter-press and one colored plate, have appeared during the year 1863; and the work is intended to be continued at the rate of five numbers in a year; the price 3 florins each. The extent, character, and importance of this publication may be judged of from the following brief analysis of the contents of the four numbers now before us.

First we have, from the indefatigable Prof. Miquel himself, a revision of the *Araliaceæ* of the Indian Archipelago, with an analytical conspec-

tus of the known genera of the order, and the revision of certain genera, as, for instance, of *Aralia* (from which he again excludes *Panax*). An additional case of identity of peculiar N. E. American with N. E. Asian species, of much interest, is adduced, viz: that the Linnæan *Aralia Chinensis*, *A. Mandschuria* Regel, and the Japanese *A. canescens* Sieb. & Zucc., are all referable to our own familiar *A. spinosa!* Specimens from Georgia, collected by the late Mr. Beyrich, are provisionally named and described as *A. Georgica* Miq., and thus referred to the consideration of American botanists, as to whether it be a distinct species or not. We find in our own collections no indications of a second species allied to *A. spinosa*, nor any specimens with such thin and coarsely toothed leaflets as in ours of *A. Mandschurica*. But the plant is so unmanageable in the herbarium, from the size of the leaves, &c., that a full suite of specimens is hardly to be met with. The view that the Ginseng of Tartary, the Himalayas, and Japan is of the same species as the North American, is adopted.

Secondly, the *Ericaceæ Japonicæ* are elaborated by Prof. Miquel. We are interested to find that a new Japanese true Cranberry is described, also one related to our *Vaccinium erythrocarpon* of the Alleghanies, but with rudimentary dorsal awns to the anthers, thus still more bridging over the difference between *Vaccinium* proper and *Oxycoccus*. Of the latter group, accordingly, Japan would seem to have not only *V. Oxycoccus* and *V. macrocarpon*, which are associated in North America, but even a third species of the same type, and an analogue of our peculiar *V. erythrocarpon*, as well as a species which comes nearer to our Blueberries than any other out of Eastern North America (*V. Smallii* Gray), but still wants the false partitions which characterize ours. More interesting still, *Chiogenes hispidula* turns up in Japan; but thus far only sterile specimens have been gathered. Two Azaleas of the American type are described, with one of which *A. Japonica* Gray, is probably to be identified. *Monotropa uniflora* now appears, as was to be expected, having been detected in the Himalayas.

The *Ericaceæ* of the Indian Archipelago, which follow, are of less interest to us.

Fourthly, *Filices, præsertim Indicæ et Japonicæ*, are described by Professor Mettenius, but thus far only *Gleicheniaceæ* and *Cyatheaceæ*.

Fifthly, the *Equisetaceæ*, by Dr. Milde of Breslau, prefaced by a succinct conspectus of all the known species, only twenty-six in number, arranged according to their affinities, and followed by a particular account of the many varieties of several species.

Sixthly, by Prof. Miquel we have *Ampelideæ Novæ*, with an arrangement of *Vitis* (including *Cissus*, *Ampelopsis*, and *Pterisanthes*), under seven sections, and a critical view of the Indian and Japanese species, with several American. Prof. Miquel confirms the identification of *Vitis Labrusca* of Thunberg (Japan) with our *V. Labrusca*.

Seventhly, *Adnotationes de Cupuliferis*, by the same author. Ninety species of *Quercus* are annotated or enumerated, and two genera propounded, without admitting which it is declared that *Quercus* and *Castanea* cannot be kept apart, viz: *Callæocarpus*, of two Sumatran species, and *Castanopsis* of Don (as a section of *Quercus*), of numerous species variously regarded as Oaks or Chestnuts.

Eighthly, the *Araceæ*, by Dr. Schott, the renowned monographer of the order. A sheet or two of the first part ends the No. 4 of these interesting Annales. A. G.

3. *Martius, Flora Brasiliensis:* fasc. 33–35. July, 1863.—These fasciculi form a volume of no small interest. They comprise the Brazilian *Eriocaulaceæ* by Kœrnicke, the *Gnetaceæ* by Tulasne, the *Cycadaeæ* and *Coniferæ* by Eichler, and the *Ericaceæ* by Meisner.

Of these the *Eriocaulaceæ* only are numerous in species. They here occupy almost 250 pages of letter-press, illustrated by 26 plates. Brazil is the head-quarters of this remarkable tribe, claiming 210 out of the 326 recorded species, and 184 species of its largest genus, *Pæpalanthus;* while of its most cosmopolite genus, *Eriocaulon*, it is second to India. Indeed, the Brazilian empire, with the tropical regions to the north of it up to the Isthmus, contains almost three-quarters of the known species, and members of all of the six genera, except *Lachnocaulon*, of the southern United States. All the *Eriocauloneæ* belong strictly to the eastern side of the American continent; and those of the Old World are almost equally oriental. The only European one, our *Eriocaulon septangulare*, seems as if a waif from North America, and probably was so; while the greater part of that genus is to be found in India and further east, three species reaching westward to Zanzibar and Abyssinia, three to Bourbon and Mauritius, and four to Madagascar. On the western coast of tropical Africa there appear to be five species of *Eriocaulon*, and at the Cape three more, accompanied by a solitary *Pæpalanthus*, an otherwise wholly American genus, with the exception of a single out-of the-way species at the Isle of Bourbon. The little genus *Mesanthemum*, in character intermediate between *Pæpalanthus* and *Eriocaulon*, consists of three species, one in Brazil, one in Sierra Leone, and one in Madagascar. *Lachnocaulon*, as already noticed, belongs to the Southern Atlantic United States. The two remaining genera, *Tonina*, of a single species, and *Philodice*, of two species, are confined to Brazil and adjacent districts. The Brazilian species appear to have been faithfully elaborated by Kœrnicke, who has also furnished the excellent analyses which enhance the value of the numerous plates.

The Brazilian *Gnetaceæ*, elaborated by Tulasne, comprise 7 species of *Gnetum* and 4 of *Ephedra*. The gymnospermous view is adopted, *Ephedra* being described as having an ovule with a single coat, the apex of which is produced into a styliform tube, *Gnetum* with two coats, the inner prolonged into an exserted tube.

The *Cycadeæ*, contributed by a new collaborator, Dr. Eichler, are merely two species of Zamia, both of which are figured.

The *Coniferæ*, by the same author, as to the Brazilian flora, include only one *Araucaria* and two species of *Podocarpus*, all three most elaborately illustrated by figures, as also is *Cupressus Lusitanica*, an oriental Cypress, planted in Brazil. The interest of the article lies in a conspectus of an arrangement of the order, and in an *Excursus Morphologicus* on the structure of the flowers in *Gymnospermæ*. Dr. Eichler's arrangement throws the *Taxodineæ* as well as *Araucarieæ* into the suborder *Pinaceæ*, the former being supposed to have two superposed scales coalescent into one; the latter to have the proper carpellary scale obsolete.

The tribe *Araucarieæ* is characterized by multilocular anthers, the cells linear and hanging free, cupressaceous (i. e., simple and globose) pollen, simple scales to the female ament [which appear to answer to bracts and not carpophylls], inverted ovules, and naked buds.

The tribe *Abietineæ*, by bilocular anthers, with oblong and separate cells, pinaceous (rarely cupressaceous) pollen, double and separate scales to the female ament, inverted ovules, and scaly buds.

The tribe *Cunninghamieæ*, by the 2 or 3 short cells to the anthers, cupressaceous pollen, double scales to the female ament (the inner one smaller) but completely or incompletely coalescent into one body, inverted ovules, and mostly naked buds. To this tribe our author doubtfully refers *Sequoia!*

The tribe *Taxodineæ*, by the 3–5-locular anthers, with roundish apposite cells, cupressaceous pollen, the scales of the fertile ament double, nearly equal, and coalescent, or their tips free, the ovules erect, and the buds naked.

The suborder *Cupressaceæ* in this arrangement consists of only one tribe, *Cupressineæ*, with the usual characters, and including three subtribes, founded on the nature of the ament,—strobilaceous and closed, of peltate scales in the true *Cupressineæ*, strobilaceous but not peltate in *Actinostrobeæ* (of which *Thuja* is the Linnæan type), galbulaceous in *Juniperinæ*, and of free erect scales in *Diselmeæ* (*Diselma* Hook. f.).

The suborder *Taxaceæ* has four tribes; all but one with bilocular anthers; the *Dacrydieæ* with pinaceous pollen, an orthrotropous or rarely subanatropous ovule with its two integuments separate, and naked buds; *Podocarpeæ*, with its pinaceous pollen, an erect anatropous ovule, the integuments of which are coalescent; *Taxeæ*, with an anther of three or more cells, cupressaceous pollen, orthotropous erect ovules, scaly buds; and linear leaves; *Salisburyeæ*, differing from the last in the bilocular anthers, and the dilated fan-shaped leaves (in the Ginkko) or with the leaves reduced to teeth and phyllodineous expansion of the branches taking the place of foliage (in *Phyllocladus*).

The *Excursus Morphologicus*, without much striking novelty, is a very clear and cogent morphological disquisition upon the structure of the flowers of the *Gymnospermæ*. No good abstract can be now given without entering into the history of various recent discussions,—for which we are not yet ready. Suffice it to say, at present, that Dr. Eichler convincingly defends the gymnospermous doctrine, impugned by Agardh, Baillon, and Parlatore, and adopts and fortifies A. Braun's view that the inner or ovuliferous scale in the *Abietineæ* is a metamorphosis of an axillary diphyllous (in *Pinus*, or in *Cryptomeria*, &c., a 2–5-phyllous) shoot, the axis of which is undeveloped, and the leaves or scales united into one. Establishing the foliar nature of the carpophyllous scales, whether simple and of the first order, as in *Cupressineæ*, or of the second order and more or less compound, as in *Abietineæ;* and also settling it that each antheriferous scale, however many anther-cells it may bear, answers to one leaf and therefore to one stamen, he first compares Coniferous flowers with those of *Cycadeæ*, where he cannot doubt that the scales or leaves themselves bear the ovules; and so he naturally infers the same of the ovules of *Abietineæ* and *Cupressineæ* (according to the Brunonian

view); while the ovule of *Taxus*, &c., as in *Gnetaceæ*, is regarded as a direct metamorphosis of the axis. But, having settled that the whole of a simple male catkin of a Conifer, consisting of few or many stamineal leaves, developed in regular phyllotaxis on a simple axis, must logically be held to constitute one male flower (under which view the andrœcium of *Dammara* and *Araucaria* neatly homologizes with *Cycadeæ*), it follows that the whole female catkin of a *Cupressinea* would equally constitute one flower, while in a Pine or Fir each ovuliferous scale, and in a Yew, the ovule itself would be a flower. Unwilling to accept such a conclusion, which makes the ament of a Conifer in one case an inflorescence and in other apparently quite similar cases a single flower, Dr. Eichler propounds instead the idea that the female scales are not carpophylls, but bracts, not themselves really ovuliferous, but with ovules borne in their axils—as they evidently are in *Podocarpus* sec. *Stachycarpus*, and not far from it in most *Cupressineæ*,—although often adnate to their face. Each ovule, accordingly, is a flower, in all *Coniferæ* with simple scales; and this view is extended even to *Taxus* and *Torreya*, the ovule or flower of which is concluded to be only quasi-terminal. The female flowers, or ovules, in all the above cases are "*primo gradu axillares.*" But in *Abietineæ*, and in whatever other *Coniferæ* have their fruitful scales in the axil of a bract, the flowers or ovules are "*secundo gradu axillares.*" The female flower in all *Coniferæ*, accordingly, is concluded to be an ovule, and this is the metamorphosis of a lateral axis; while the leaves of a primary axis are metamorphosed into stamens. The latter we see frequent confirmation of in monstrous catkins of *Abies*, where some of the subtending bracts become polliniferous.

One good inference which Dr. Eichler draws from these morphological conclusions is that the *Coniferæ* constitute but one natural order, equivalent to *Gnetaceæ*, the highest of Gymnosperms, and to *Cycadeæ*, the lowest. The latter, in view of their analogies to Ferns and their simple foliar metamorphosis, he regards as the "archetype" or rather primordial type of Phænogams: while in the *Coniferæ*, which are analogous to *Lycopodiaceæ* as *Cycadeæ* are to Ferns, the metamorphosis affects the axis as well as the leaves. At length in *Gnetaceæ* a perianth and even structurally hermaphrodite flowers appear, realizing—though still on the gymnospermous plan—the floral type of ordinary Phænogamous plants. Dr. Eichler has studied and appreciated Dr. Hooker's paper on the wondrous *Welwitschia*, of which we gave some account in vol. xxxvi, p. 433, &c. What a pity this beautiful "synthetic type" did not come to light in paleozoic botany!

Finally Dr. Eichler adopts the view of Brongniart, that the Gymnosperms constitute a true natural class, intermediate between Cryptogams and Angiosperms. No new reasons are adduced in support of this view; but on the whole it must be admitted that the grounds for the maintainance of Gymnosperms as a peculiar type or class grow stronger; although we could not say with propriety that they are intermediate between proper Phænogamous and Cryptogamous plants.

The Brazilian *Ericaceæ*, elaborated by the practised hand of Meisner, are chiefly rich in *Vaccineæ*, and especially in *Gaylussacia*, of which, after large reductions, Prof. Meisner enumerates 36 Brazilian species.

Much as this tribe luxuriates in these regions, it appears not to furnish esculent fruit, as in our cooler northern regions. Of the proper *Ericineæ* the largest genus is *Leucothoë*, with 23 species. There are no *Pyroleæ*, and no *Monotropeæ* known as yet in the Brazilian Empire; but *Monotropa uniflora* occurs as near as the southern part of New Granada.

A. G.

4. *Species Genera et Ordines Algarum;* auctore JACOBO GEORGIO AGARDH. Vol. II. pars 3 : 2. Lund, 1863. pp. 787–1291. 8vo.—We have had the gratification of receiving another and large instalment of this classical work. It comprises Agardh's Ordo XVI, *Rhodomeleæ*, consisting of seven tribes and thirty-three genera. Among them is an Australian genus, of two species, named *Cliftonia* by Harvey,—a name long ago pre-occupied in Phænogamic Botany. The work is as excellent in typography and arrangement as it is in scientific character. A. G.

5. *Phycologia Australica; a History of Australian Seaweeds.*—We take this opportunity to announce that Professor Harvey has completed this, perhaps the most beautiful and one of the most important of his unrivalled illustrated works. It forms five volumes, royal 8vo, containing 300 colored plates. It is published by Lovell Reeve & Co., and costs in London a little less than £8. A. G.

6. *Thesaurus Capensis*, &c. Vol. II, No. 1, 1863.—Professor Harvey, in the midst of indefatigable labors both in Algology and upon the Cape Flora, has found time to bring out during the past year the first part of a new volume of this illustrated work, containing plates 101 to 125 inclusive. The lithography is better than ever; and several of the plates are devoted to subjects of curious interest; five or six illustrate remarkable Orchids, and one exhibits an extraordinary *Pelargonium* with its petals slit up into fine shreds. *Montinia acris* is figured, and the fact mentioned that it has three-cornered pollen, so that it really belongs to the Evening-Primrose family after all. A. G.

7. *The Plants indigenous to the Colony of Victoria; described by* FERDINAND MÜLLER, Ph.D., M.D., F.R.S., &c. Vol. I, *Thalamifloræ.* 1860–1862. pp. 242, roy. 4to, with 23 plates.—When, in the number for September last, we noticed the *Flora Australiensis*, with which Dr. Müller is so honorably and usefully connected, we had not yet received our copy of the present publication. This is the first volume of a more detailed flora of Victoria Colony, with full ordinal, generic, and specific descriptions, and many critical observations; also with a considerable number of well-designed plates, executed in the Colony in a very hopeful manner. It is published by the Colonial Government, which appears to have been always ready to promote worthy scientific investigations. And we trust it will be carried to completion, notwithstanding the more comprehensive Australian Flora. A. G.

8. *Notice sur les Plantes de Michaux et sur son Voyage au Canada et a la Baie d'Hudson, d'après son Journal manuscrit et autres documents inédits;* par l'Abbé OVIDE BRUNET. Quebec.—The professor of Botany in the Laval University, Quebec, makes an appropriate *debût* in this interesting publication. It is a study of the botanical explorations and journeyings of the elder Michaux in Lower Canada and, by way of the Saguenay River and Lake Mistassius, nearly to Hudson's Bay.

While pursuing botanical studies at Paris, Prof. Brunet had noted with care, all the Canadian stations, in the herbarium of Michaux, and since his return he has been able to retrace every step of this hardy explorer and pioneer by means of his manuscript journals preserved by the American Philosophical Society at Philadelphia. Attention was first called to this interesting manuscript, and an abstract given, in our vol. xlii (old series) about twenty-two years ago,—chiefly referring, however, to Michaux's explorations in the Alleghanies of the Southern States. In the present article we have a full account of the northern exploration, in the summer and autumn of 1792, with lists of some of the principal plants collected at each station, and useful notes upon the geographical distribution or range of the forest-trees of the region.

Upon Michaux's remark that the *Gaultheria procumbens* disappears about ten leagues above Lake St. John, Prof. Brunet adds a foot-note relative to the name of the physician of Quebec to whom Linnæus or Kalm dedicated this well-known plant. Kalm wrote the name *Gaulthier;* hence *Gaultheria.* But, relying upon the French Academy of Sciences, in a volume of whose memoirs the name is written *Gautier*, Endlicher changed the orthography of the genus to *Gautiera.* Others have plausibly conjectured that his name was *Gualthier* or *Gualtier*, hence *Gualthieria* or *Gualtiera.* But Prof. Brunet has settled the matter by referring to the registers of the parish of *Notre-Dame de Quebec* (e. g., 1751, Aug. 26), where the signature of this physician is found, written *Gaultier. Gaulteria* or *Gaultheria*, the original form of the generic name, is therefore not much amiss, and scarcely needful to alter; although *Gaultiera* would be more correct, and may at length be made to prevail.

A. G.

9. *Botany of N. W. America along the British Boundary.*—Dr. David Lyall, the Surgeon and Naturalist of the British Commission for surveying this boundary, made a large and important collection of dried plants, to the excellence of which we bear grateful testimony. In the Proceedings of the Linnæan Society, No. 27 (1863), we find an interesting account: 1. of the character and extent of this botanical collection, and of the distribution of the duplicates (a complete set being laid into the Hookerian herbarium) to various public museums and botanists—"those having been selected in which (according to the authorities at Kew) they would be most beneficial to science." 2. "The General Character of the Regions traversed," from the Cascade Mountains to the plains of the Saskatchewan, is detailed. 3. "The Botanical Aspects of the Regions traversed" is considered at some length. 4. "Notes on the Distribution of the principal Trees met with near the 49th degree of latitude, and the elevation to which they reached, between the Gulf of Georgia and the Rocky Mountains," contains interesting matter relating to the *Coniferæ* of that region. A. G.

10. *Ink-Plant* (*Coriaria thymifolia*).—Prof. Jameson, of the University of Quito, writes to Dr. Hooker, with ink consisting simply of the expressed juice of the berries of this *Coriaria*, remarking that he generally uses this in preference to ordinary ink, as it is not so apt to corrode the steel pen. The writing is at first reddish, but turns black in a few hours. He remarks: "There is a tradition here respecting this vegeta-

ble juice that merits attention. It happened, during the Spanish administration, that a number of written documents, destined to the mother country, were embarked in a vessel and transmitted round the Cape. The voyage was unusually tempestuous, and the documents got wetted with salt water. Those written with common ink became nearly illegible, whereas those written with 'Chauchi' (the name of the juice) remained unaltered. A decree was thereupon issued that the Government communications should in future be written with the vegetable juice. I do not vouch for the correctness of this statement, but I have constantly heard it repeated from different sources."—*Jour. of Proceed. Linn. Soc.*, No. 27.

11. *Botanical Necrology for the year* 1863.—Biographical notices have already appeared in this Journal of the lamented *Dr. Short*, who died on the 7th of March, and of *Dr. Darlington*, who died on the 23d of April last. The year 1863 has closed without farther additions to our home list. Of European botanists we have to record only the following:—

Professor Martin Martens, of the University of Louvain, who, in connection with Galeottii, published the collections of the latter in Mexico. He died Feb. 8, at the age of 75 years.

Dr. Christian von Steven, who botanized in the Caucasus many years ago, published several memoirs, and whose name is well known in connection with the Russian flora. He died at Sympheropol, on the 17th of April last year, at the venerable age of 91 or 92.

Prof. C. H. B. Alfred Moquin-Tandon, recently of the Faculty of Medicine at Paris, formerly Professor of Botany at Toulouse. He was a pupil of Dunal at Montpellier, and one of the earliest to take up the theory of *deduplication*, which he maintained in his inaugural thesis at Montpellier, published in 1826. His principal botanical writings (for he wrote also upon zoological and other subjects) are his succinct monograph of *Chenopodiaceæ*, published in 1840; his admirable *Elémens de Tératologie Végétale*, in 1841, and his elaboration of the *Salsolaceæ* (*Chenopodiaceæ*), *Amarantaceæ*, and the allied groups which mainly compose the second part of the thirteenth volume of DeCandolle's Prodromus:—so that he was one of the foremost botanists of the day.

And now with deep sorrow we have to add the name of

Francis Boott, M.D., who died at his residence in London on Christmas morning, in the 71st year of his age. He was born in Boston, on the 26th of September, 1792. His father, Kirk Boott, came to this country early in life, from Derbyshire, England, became a successful merchant in Boston, was one of the pioneers of manufacturing enterprise here, and one of the founders of Lowell,—the type, if not wholly the original, of New England manufacturing towns. His Boston residence was on the site now occupied by the Revere House, of which the Boott mansion forms a part. Francis Boott entered Harvard University in the year 1806, and took his Bachelor's degree in 1810. A year after, being then in his nineteenth year, viz., in the summer of 1811, he sailed for England, intending to enter a counting-room in Liverpool, as a preparation for mercantile life. This plan, however, was soon relinquished; and the three succeeding years were mainly spent with his relatives and their friends near Derby, where he made the acquaintance of Mrs. Hardcastle, his future mother-in-law, who was something of a botanist, and

where he formed both the scientific and social attachments which determined the aims and secured the happiness of his whole after life. Returning to Boston at the close of the year 1814, he engaged with enthusiasm in botanical pursuits, and amassed a good collection of New England plants. In the summer of 1816, he took a leading part in a botanical exploration of the mountains of New England, ascending, in the course of one journey, Wachusett, Monadnock, Ascutney, and Mt. Washington; and, later in the season, Dr. Boott with his brother visited and ascended Moose-hillock. His companions in the extended and then formidable tour which culminated in the White Mountains—then to be reached only by a laborious journey of two days on foot—were Francis C. Gray, Judge Shaw, Nathaniel Tucker, and Dr. Jacob Bigelow, the Nestor of New England botany, now the sole surviving member of the party. An interesting account of the ascent of Mt. Washington, written by Dr. Bigelow, was published at the time in the fifth volume of the New England Journal of Medicine and Surgery.

In the year 1820 Dr. Boott crossed the Atlantic for the last time, and, proceeding to London, entered upon the study of medicine, under the direction of the late Dr. Armstrong. He continued his medical studies at the University of Edinburgh, where he took the degree of M.D. in 1824. The next year he established himself in London, we believe in the very house in Gower street where he resided until the day of his death. He was soon associated with his near friend and former teacher in the work of instruction, becoming Lecturer on Botany in the Webb Street School of Medicine, where Dr. Armstrong was Professor of Materia Medica.

"His lectures are said to have been admirable, both in matter and style, and to have excited much enthusiasm; whilst his untiring efforts to promote the welfare of his pupils in other ways were so deeply and generally felt, that, on the eve of his too early withdrawal from the lectureship, they in one day raised a large subscription to present a testimonial to their friend and teacher;—a tribute which, with characteristic modesty and consideration, was declined as soon as heard of. He was, however, afterwards persuaded to accept a collection of books instead, in remembrance of their grateful feelings and good will."

The early death of Dr. Armstrong, cutting short a distinguished career, imposed upon his friend the duties of a biographer and expositor. Accordingly, after much preparation, Dr. Boott, in the year 1834, published two octavo volumes, entitled: "Memoir of the Life and Medical Opinions of John Armstrong, M.D.; to which is added an Inquiry into the facts connected with those forms of Fever attributed to Malaria and Marsh Effluvium." He published, besides, in the year 1827, two Introductory Lectures on Materia Medica, which give a good idea of his excellence as a teacher. Although he did not continue in this career, his interest in medical and scientific education never abated. He was an active promoter of the establishment of London University (now University College), and was for more than a quarter of a century an influential member of its Senate and Council. He was successfully engaged for some time in medical practice, and was for many years Physician to the American Embassy; but he gradually withdrew from professional cares and toils to more congenial literary and scientific pursuits. As

early as the year 1819 he had become a Fellow of the Linnæan Society of London; and afterwards, for the last twenty-five years, he gave it continuous and invaluable service as Secretary, Treasurer, or Vice President.

At one time it was thought that Dr. Boott might be recalled to his native country and to an active scientific life. Nearly thirty years ago he was offered the chair of Natural History in Harvard University,—a chair which had remained vacant since the death of Professor Peck in 1822, although its duties were for several years fulfilled by the late Mr. Nuttall. After Nuttall left Cambridge to explore Oregon and California, arrangements were made to endow the vacant professorship properly in case Dr. Boott would accept the place. Although the offer was declined, we have been told that he intimated a willingness to accept it if the chair were simply that of Botany; and when informed that he might practically make it so, although the title was unchangeable, he insisted that he would not be called a professor of Natural History, while he could pretend to a knowledge only of Botany.

Nearly thirty years ago, Dr. Boott began seriously to devote his energies to the special work upon which his scientific reputation mainly rests, viz., to the study of the vast and intricate genus *Carex*. The first result of these studies appeared in his elaboration of the *Carices* of British North America in Sir Wm. Hooker's Flora Boreali-Americana, published in 1840. Other papers upon *Carices* were contributed to the Transactions of the Linnæan Society, the Journal of the Boston Society of Natural History, &c. As it had always been the greatest pleasure, we might say the business, of his life to assist others, so now friends and correspondents from all parts of the world hastened to place in his hands the fullest sets of their collections in this difficult genus; and he was able to study, in the unrivalled caricological collection he thus formed, and in the various public and private herbaria to which he had access, almost all of the 600 or more species which the genus was computed by him to comprise, to compare them in numerous specimens of their various forms, and to examine them, group after group, with untiring and closest scrutiny. At length, early in the year 1858, he gave to the world (literally *gave to the world*) the first volume of his great work, entitled Illustrations of the Genus Carex, a folio volume with 200 plates, admirably representing about that number of species. A very large proportion of them were North American species, in which he naturally always took a special interest. In the letter of dedication of this work to his friend John Amory Lowell, Esq., of Boston, Dr. Boott states that his original design "was limited to the illustration of the *Carices* of North America," but that the large collections brought by Dr. Hooker from the East Indies, and placed in his hands for study, caused him to extend his plan, and to endeavor to illustrate the genus at large. With characteristic modesty he makes no allusion to the years of labor and the large amount of money (savings from a moderate income by a simple mode of life) which the volume had cost him; the drawings, engravings, and letter-press having been produced at his sole individual expense, and the larger part of the copies freely given away. Nor did he put forth any promise to continue the work. But in 1860 Part Second quietly appeared, without a word of preface. This contains

110 plates. Two years after, this was followed by Part Third, with 100 plates, making 410 in all; and it is understood that the materials of a fourth volume are left in such forwardness that it may perhaps be published by his surviving family.

Our own estimate of this work has been recorded in the pages of this Journal, as the successive volumes were received. The motto which the author placed upon his title-pages:—

> "The man who labors and digests things most,
> Will be much apter to despair than boast,"

is felicitously expressive both of the endless difficulties of the subject, and of his undervaluation of his endeavors to overcome them. A most competent judge briefly declares that,—

"This work is certainly one of the most munificent contributions ever made to scientific botany, besides being one of the most accurate; on which account it certainly entitles its author to take a much higher place amongst botanists than that of an amateur, which was all that his modesty would allow him to lay claim to."

Dr. Boott's health, which had long been delicate, was much shattered in the winter of 1839–40 by a dangerous attack of pneumonia. "From this time he had repeated slight attacks; but no alarming symptoms occurred till June 1863, when the remaining lung gave way, and from that time he never fairly rallied. He died at his residence, 24 Gower street, on Christmas Day,—retaining to the last his faculties and all the characteristics of his most admirable life."

Dr. Boott was a man of singular purity, delicacy, and goodness of character, and of the most affectionate disposition. Few men of his ardent temperament and extreme sense of justice ever made less enemies or more friends. To the latter he attached himself with entire devotion. If there were any of the former, probably no man ever heard him speak ill of them. His published works suffice to place his name imperishably upon the records of science. But only his contemporaries and friends will know how much he has done to help others, and how disinterestedly and gracefully that aid was ever rendered. He took with him to England, upon his return in the year 1820, a valuable herbarium of New England plants, especially those of the White Mountains, which were then rare and little known. He must have valued this collection highly, and have expected to use it. But he presented the whole of it to Dr., now Sir Wm. Hooker, when he saw how serviceable it would be to him in the preparation of the *Flora Boreali-Americana.* His British herbarium was long ago similarly given to a then young American botanist. Another who, twenty-five years ago, called to take leave of him upon returning to this country, found, as he left, the seat of his cab loaded with choice botanical books, which Dr. Boott had at the moment sent there from the shelves of his own library, where they were not duplicates. We know of one or two instances where he had commenced a critical study of a particular genus with a view to publication, but, upon learning that another person had taken up the same subject, he despatched to him his own notes and other materials. The Linnæan Society of London owes no little of its present prosperity to his long and faithful services and his wise counsels. He kept up an active correspondence with his friends in this country;

and for more than thirty years our young professional men, naturalists, and others who have visited Europe, have experienced cordial welcome and thoughtful kindness at his hands. The following gives a good idea of the man:—

"When practising as a physician he discarded the customary black coat, knee-breeches, and silk stockings, for the very good reason that sombre colors could not but suggest gloomy ideas to the sick; and he was one of the first who adopted the custom, now universal in the profession, of dressing in ordinary costume. In doing this Dr. Boott adopted the blue coat, gilt buttons, and buff vest of the period, which he continued to wear to the last, and with which dress his casual acquaintance, no less than his personal friends, will ever associate him. In person he was so tall and thin as almost to suggest ill-health; and the refinement of his manners, his expression, address, and bearing were in perfect keeping with his polished mind and many accomplishments."

The preceding extracts are all from an excellent article in the Gardener's Chronicle for January 16, to which we are much indebted. In the first volume of the late Dr. Wallich's splendid *Plantæ Asiaticæ Rariores*, published in the year 1830, is the figure of a handsome and curious Butomaceous plant, BOOTTIA CORDATA, a genus dedicated "*in honorem Francisci Boott, Americani, botanici ardentissimi et peritissimi, amici dilectissimi, non minus animi probitate quam scientiarum cultu, et morum suavitate egregii.*" A. G.

Jacques Gay.—We have just heard of the death of this excellent man and botanist, but without details. The event must have been sudden, as we had news of him almost down to the close of the year. He was born in Switzerland, was a pupil of Gaudin, who bequeathed to M. Gay his herbarium; but most of his years, which were little under fourscore, were passed in Paris. The weekly *réunion* of botanists in his modest apartments at the *Petit Luxembourg*, which has continued through a long life-time, is now done away; and to botanists Paris will seem other than it was, without him. A. G.

V. ASTRONOMY.

1. *Comet IV*, 1863.—This comet was discovered by M. Tempel at Marseilles on Nov. 5th. It was visible to the naked eye, shining as bright as a star of the 5th magnitude. It appeared as a condensated nebula, showing a tail about 2° long. The following elements were computed by Mr. H. Romberg.

$$\begin{aligned} T &= 1863,\ \text{Nov. } 9{\cdot}49923, \text{ Greenwich m. t.} \\ \pi &= 94^\circ\ 46'\ 10''{\cdot}6 \\ \Omega &= 97\ \ 31\ \ 15\ {\cdot}2 \end{aligned} \Big\} \begin{array}{l}\text{Apparent equinox} \\ \quad\text{Nov. } 13{\cdot}5.\end{array}$$
$$\begin{aligned} i &= 78\ \ \ 6\ \ 46\ {\cdot}5 \\ \log. q &= 9{\cdot}849148 \end{aligned}$$
Motion direct.

The following are some observations of this comet.

	m. t. Lubeck.	R. A.	Dec.
Nov. 19,	$18^h\ 30^m\ 43^s{\cdot}0$	$13^h\ 19^m\ 32^s{\cdot}02$	$+13^\circ\ 22'\ 2''{\cdot}0$
20,	18 10 41 ·0	13 27 46 ·81	+14 48 50 ·2

		m. t. Greenwich.	R. A.	Dec.
Dec.	3,	$6^h\ 16^m\ 17^s$	$15^h\ 46^m\ 35^s{\cdot}8$	$+30°\ 16'\ 17''$
		m. t. Josephstadt.		
Dec.	8,	5 48 50	15 46 9 ·04	+30 14 15 ·2

This comet was seen during November and December by several persons in this country, having been visible to the naked eye, and by some was confounded with the comet discovered by Prof. Watson Jan. 9th.

2. *Comet V*, 1863.—This comet was discovered on Oct. 9th by Mr. Bäcker at Nauen. The following elements were computed by Mr. Hermann Romberg.

$$\begin{aligned} T &= 1863,\ \text{Dec. } 27{\cdot}70863,\ \text{Greenwich m. t.} \\ \pi &= 180°\ 17'\ 53''{\cdot}4 \\ \Omega &= 104\ \ 51\ \ 28\ {\cdot}8 \end{aligned} \Big\}\ \text{Apparent equinox of Oct. } 14{\cdot}5.$$

$$\begin{aligned} i &= 82\ \ 16\ \ 29\ {\cdot}4 \\ \log. q &= 0{\cdot}131934 \end{aligned}$$

Motion direct.

This comet appeared as an oblong nebula, strongly condensed in the middle. Its diameter was about 1′, and it shone as a star of the 8th magnitude.

3. *Comet VI*, 1863.—On the 28th of December, 1863, M. Respighi, Director of the Observatory at Bologna discovered a new comet (the sixth of 1863). It exhibited a nebulosity condensed toward the centre, with the trace of a tail about half a degree in length. The following are two observations of Dec. 28th.

m. t. Bologna.	R. A.	Dec.
$6^h\ 43^m\ 4^s$	$18^h\ 49^m\ 24^s{\cdot}80$	$25°\ 57'\ 33''{\cdot}7$
18 11 2	18 50 1 ·76	26 13 2 ·2

M. E. Weiss has calculated the following elements of this comet.

Perihelion passage,	1863, Dec. 27·9915
Longitude of perihelion,	60° 31′ 22″
Longitude of node,	304 47 17
Inclination,	64 43 40
Perihelion distance,	0·77301
Motion direct.	

M. Weiss remarks that these elements resemble those of the comets of 1490 and 1810, the three perihelia being separated by intervals of $53\frac{1}{2}$ years, and of $320 = 6 \times 53$ years.

	Comet of 1490.	Comet of 1810.
Perihelion passage,	Dec. 24·477	Sept. 29·1062
Longitude of perihelion,	58° 40′	52° 44′ 42″
Longitude of node,	288 45	310 21 2
Inclination,	51 37	61 11 15
Perihelion distance,	0·7376	0·97579
Motion	direct.	direct.

This comet was discovered at Ann Arbor on the 9th of January, as announced in the following letter from Prof. Watson:

"Observatory, Ann Arbor, Michigan, 1864, Jan. 13.

GENTLEMEN:

I have the pleasure to inform you that I discovered a new comet on the evening of Saturday, Jan. 9th, at $6\frac{1}{2}$ o'clock. I have observed the following accurate positions:

	Ann Arbor M. T.	Comet α.	Comet δ.
1864, Jan. 10,	$6^h\ 57^m\ 7^s$	$19^h\ 14^m\ 3^s{\cdot}37$	$+34°\ 6'\ 5''{\cdot}9$
11,	6 18 57	19 17 15·31	34 52 52·2
12,	6 5 51	19 20 53·35	35 42 47·0

From these places I have derived the following elements of the orbit:

$$\left.\begin{array}{rl} T = & 1863,\ \text{Dec. } 27{\cdot}1413 \text{ Washington M. T.} \\ \pi = & 60°\ 17'\ 39''{\cdot}0 \\ \Omega = & 304\ \ 40\ \ 49\ {\cdot}0 \end{array}\right\} \text{App. equinox, Jan. 11th.}$$
$$\begin{array}{rl} i = & 63\ \ 55\ \ 38\ {\cdot}5 \\ \log q = & 9{\cdot}885810 \\ & \text{Motion direct.} \end{array}$$

The comparison of the middle place gives:

$$\text{c.—o.}$$
$$\Delta\lambda \cos\beta = -2''{\cdot}9 \quad \Delta\beta = -15''{\cdot}0$$

The comet is large and bright, with a tail $1\frac{1}{2}°$ in length, and a nucleus strongly condensed at the centre.

The above elements almost exactly resemble those of the comet of 1810, so that there can be very little doubt of the identity of the two comets. Whether this is the first return to the perihelion since 1810, or whether it has returned several times unperceived, must be decided by subsequent observations. Very truly yours,

JAMES C. WATSON."

This comet was barely visible to the naked eye during the latter part of January, and in a comet-seeker exhibited a tail about 2° in length.

4. *Notes on η Argus;* by F. ABBOTT, Esq. (from Proceedings Royal Astronomical Society, Nov. 13, 1863.)—That the duration of this star's apparition is variable to a great extent is certain; and by comparing the present description with the monograph of Sir J. Herschel, taken at Cape of Good Hope, it will, I think, appear conclusive that the apparition of the surrounding nebulæ is also variable.

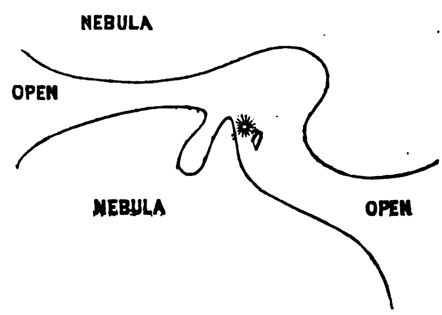
Messier recommended careful observations to be made on such objects, with a view to ascertain whether or not any indications of change in form or structure are exhibited. That such changes have taken place is already on record. An instance is afforded by the remarkable nebula surrounding θ in the constellation of *Orion*, which Huyghens discovered in 1656, and noted in his *Systema Saturnium;* from comparison of which Sir Wm. Herschel, by his own observations from 1783 to 1811, concluded it had undergone sensible change. Bouillard and Le Gentel maintained the same opinion in reference to the nebulæ in *Andromeda;* and of later date, Bond, Pogson, Struve, D'Arrest, and others, have observed such changes.

Sir John Herschel, when at the Cape, carefully examined *η Argus* with an 18-inch reflector; "No part of this nebula," says Herschel, "shows

any sign of resolution into stars." "It is not easy," he adds, "for language to convey a full impression of the beauty and sublimity of the spectacle which the nebula offers as it enters the field of the telescope." "It will appear," he also writes, "that every succeeding state of nebulous matter is the result of the action of gravitation, and by such steps the successive condensation of it is brought to a planetary or stellar condition. Several instances are on record which connect the planetary with the stellar appearance. In those instances wherein the collection of nebulous matter was very extensive, subordinate centres of attraction could not fail to be established, around which the adjacent particles would arrange themselves, and thus the whole mass would, in process of time, be transformed into a determinate number of discrete bodies, which would ultimately assume the condition of a cluster of stars."

That this condition is partly carried out in the object η *Argus* will be manifest by comparing the Cape description with the present one. A great difference may be caused by the optical means employed, as far as resolvability goes; but if an increased number of brilliant isolated stars, with a change in position of η *Argus*, is the effect produced by a 5-foot achromatic, and they were not exhibited to the same effect in an 18-inch reflector, it only strengthens the evidence in favor of some change having taken place in the object.

The open space, as given in the Cape Monograph, and also in the last edition of the *Outlines*, is somewhat in the form of a dumb-bell, compressed in the centre and surrounded with nebulæ, in the most dense part of which is situated η *Argus*. The appearance of the open space now assumes the form of a crooked billet, wide in the centre and open at both ends, with η *Argus* situated within the open space or dark part, and surrounded with an almost innumerable quantity of brilliant stars, many of which are arranged in groups, some being of a blue, and some of a ruddy color. They are remarkably brilliant in the dark space, and afford a good comparison with the variable star itself.



It appears somewhat paradoxical that in 1838, when examined by Sir J. Herschel, the star η *Argus* was situated in the most dense part of the nebula, and was seen as a star of the first magnitude. And now in 1863, it is out of the nebula, and, within the dark space, it appears only as a star of the sixth magnitude.

That the star's right ascension has not varied so much will be manifest. It is clear then that the dense portion of the nebula, towards the east, must have receded, leaving each end open, and η *Argus*, together with about 70 stars $\pm$ up to the 14th magnitude, as seen within the dark space.

The irregularity of this star, and the nebulosity surrounding it, involve

a principle as to whether its accession and diminution is the effect produced by distance, transits of opaque bodies, or solar spots; or whether the nebulosity surrounding η *Argus* interferes with the light emitted by the star; if so, the increase and diminution, however vacillating, become obvious.

VI. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *Account of the casting of a gigantic (Rodman) Gun at Fort Pitt Foundry,* (in a letter to the Editors, dated Pittsburgh, Penn., Feb. 1864.) —A 20-inch army gun on Rodman's plan, has lately been cast at the Fort Pitt Foundry in this city. Being the largest iron gun in the world, its manufacture necessarily awakened much interest here. Thinking therefore that your readers may feel a like interest, I take the liberty of sending you the facts of the casting, as well as the theory of this improved method.

It has long been known that there is a practical limit to the manufacture of large iron guns, cast solid, beyond which the size cannot be increased. This arises from the method of cooling, which is entirely from the exterior. Of course the first part to become solid is this exterior surface. As the cooling progresses, and the solidification proceeds toward the centre, the iron contracts and produces an enormous tension, acting in opposite directions—that is radially, in the cross section. A force of compression is felt on the exterior, to crush it inward; and one of radial elongation, exerted from within outward, on the interior, to tear it asunder. This condition of things in glass is well illustrated in the Prince Rupert's drop. In the case of solid cast iron shot, for example, there is a maximum diameter within which these can be cast without containing cavities. But beyond this point, the contraction toward the exterior, which is the first to solidify, is so great that these cavities are formed. In general the contraction is irregular and the cavities are near the upper surface. Hence it is considered preferable to cast thick shells, in which case the core locates the cavity exactly in the centre. For the same difficulties in casting large guns, it was at first proposed to apply the same remedy. That is, to cast the gun with a core, so that the contraction should be uniform from the axis to the surface.

Major—then Lieutenant—T. J. Rodman had his attention first called to the manufacture of guns of this sort,—as he recently stated before the Committee on the conduct of the war,—from the lamentable accident which occurred on board the steam frigate Princeton, in 1844. The "Peacemaker" was a wrought iron imported gun, having a bore twelve inches in diameter. Considering the conditions under which iron guns were usually cast, Major Rodman at once saw the enormous strain to which they were subjected by exterior cooling. And he also perceived that a gun thus cast was in a state of extreme tension and therefore weak. He then applied himself to the mathematical investigation of the conditions under which a central force acts. He found that Barlow had determined that the strain produced upon any material by a central force, diminishes as the square of the distance from the centre increases. Thus in a gun one calibre thick the distance from the bore to the exterior is 3, and the strain on the exterior when fired is only $\frac{1}{9}$th that on the interior. Now if the strain at the interior is the breaking strain, then this

being 1, and that at the exterior being $\frac{1}{9}$, that of each infinitely thin cylinder between these surfaces being intermediate, the effective strength of the whole will be the sum of these strains. This resistance is found to be "two-thirds of that which half a calibre in thickness would offer if the strains were all equal, as in the tensile strain." So that the resistance which a hollow cylinder, such as a gun, opposes to a central force, is, when the interior is at the breaking strain, only $\frac{2}{3}$ of that which $\frac{1}{2}$ the same thickness would oppose the rupturing of a bar of it longitudinally. And this only when the gun is entirely free from previous strain, cooled theoretically; that is, simultaneously throughout. But in the manner in which guns cast solid are cooled, we have seen that their contraction induces an enormous strain: and that this acts radially; from the circumference and the centre toward each other, tending to draw the exterior inward and the interior outward. Now this strain, produced by exterior cooling, acts in conjunction with the central force produced by the explosion of the powder, to burst the gun. This central force we have just stated gives nine times the pressure on the *interior* of a gun one calibre thick that it exerts on the *exterior*. Hence it tends to force the interior outward. But the tension in cooling acts in the same direction. And this latter force far exceeds the former, if we remember Major Rodman's statement that the interior of a gun may be burst by firing, without the tension outwardly, produced by the explosion, equalling that inwardly, given originally by contraction: hence without relieving the exterior strain.

The first plan suggested by Maj. Rodman to obviate this difficulty in the way of casting large guns, was to cast them with a core. This core allowed of some compression as the iron cooled and contracted around it. To accomplish this, he proposed to cut a thread upon the core and wind it with a wire, shaped like an H in the cross section. One of the straight sides would lie in one groove, the other in the adjoining one, and the connecting part would bind the core together longitudinally. The difficulty of procuring this peculiar shaped wire led him at last to abandon this plan. Then it was that the idea suggested itself to him of using a hollow cylinder of iron for the core, in which a stream of water should circulate. By this means the direction of cooling would be inverted, and as the interior would cool first, the contraction would take place from the exterior inward. He thus expected to oppose the action of the powder to burst the gun, instead of facilitating it. Instead of the resistance opposed to the powder being even as it is in the theoretical gun, above alluded to, $\frac{2}{3}$ds of that of the entire strength of a bar half the thickness—and of course far less in the gun cast solid—he so regulates the contraction that all the theoretical cylinders in the gun shall be brought to the breaking strain at the same instant. A condition of things in which the resistance is twice, instead of $\frac{2}{3}$ds of that given by a bar half the thickness. This is attained by having the contraction toward the centre, binding the theoretical cylinders of the gun one upon the other, as in the process of shrinking. Moreover, that part of the gun which cools most rapidly is hardest. By interior cooling, the bore is the part soonest cooled and in these guns it is less subject to wear than when it is the last part to cool, as in the old method.

The plan thus devised was offered to the Ordnance Department three several times during the years 1845 and 1846. But they thought it impracticable, and so far from adopting it they were not even willing to make a trial of its merits by actual experiment. Finally, in 1847, Major Rodman, then stationed at the Alleghany Arsenal, offered it to Messrs. Knap & Totten, proprietors of the Fort Pitt Foundry, Pittsburgh. They agreed to make a trial of the principle at their own expense and also to defray the expense of securing a patent, if he would assign one-half of his right in it to them. This he agreed to do, and the patent was accordingly issued in August, 1847. Preparations were immediately commenced and the first hollow cannon was cast at that Foundry in the winter of 1849–50. This was an 8-inch Columbiad. At the same time and from the same metal a solid gun of the same size was cast. When finished, they were proved with a charge of 10 lbs. powder and one 64 pound shot. The gun cast solid burst at the 85th fire: the one cast hollow at the 251st. In 1851, the experiment was repeated in a similar manner, with only such slight variations as experience had suggested. The guns were of the same size as in the previous experiment. The one cast solid burst at the 73d fire, the other has endured 1500 rounds and is still unbroken.

These experiments continued with the same or nearly the same form of gun until 1859, Major Rodman being engaged in experiments to determine the relative merit of the interior mode of cooling, not only by the service proof, but by ascertaining the resistance of iron of various qualities, prepared in various ways, by methods as nearly resembling the force of powder as possible. From these investigations, he came to the conclusion that the old columbiad model was radically defective. He therefore spent that year in experimenting to determine the explosive force of powder on different parts of the bore of the gun at the same instant; and the ratio of diameter to length necessary to equalize the strains tending to transverse and to longitudinal rupture. From these data, he obtains the strain, and the consequent amount of resistance required at each cross section of the gun, which gives the thickness of metal. Plotting these results, he produced the beautiful model known as the "Army gun," which far surpasses in appearance the "Navy gun," modeled by Admiral Dahlgren.

The first gun on the new model was cast at the Fort Pitt Foundry, December 22d, 1859. It was a larger gun than had ever been made successfully on the old plan. The diameter of the bore was 15 inches; the exterior diameter at the breech, 48·1 inches; total length 15 feet 10 inches; weight 49,099 lbs. This gun when finished was transported to Fortress Monroe and proved. It has been fired 505 times with full charges, and four times with smaller charges, and it is still unbroken.

Major Rodman having thus admirably demonstrated the practicability of constructing these immense guns, and their perfect safety within 1000 rounds, it only remained to increase the size of the guns thus made, until a limit should be reached. Accordingly in April, 1861, in a report made by him to the Ordnance Bureau, he recommended the construction of a gun, whose bore should be 20 inches in diameter. Owing however to the great demand for large guns, of the size already made, no attempt to cast this immense gun was made until the present winter.

The Fort Pitt Foundry stands on the Alleghany river, resting on made land. As guns are cast vertically, with the muzzle up, the first thing to be done is to sink a pit, as deep as the intended gun is long. In this instance the requisite depth would carry the bottom of the pit below the water line and water would flow in. A wrought iron tank fills up therefore half the height of the pit: and this is lined with a layer of brick 9 inches thick, which is continued to the top. A circular pit 30 feet deep and 14 feet in diameter is thus made. Within this the flask, or support for the moulding sand, is placed. It is circular in section, divided longitudinally into two parts, and transversely into three. The metal is about 1½ inches thick and is strengthened by heavy cast ribs. Its diameter is 6 feet and its weight 32 tons. It was cast by Mr. Joseph Pennock, at the Fulton Foundry. The wooden gun pattern, in two halves, which is 25 feet in length, maximum diameter 5 ft. 6 inches, and diameter at the muzzle 4 feet, is about the size of the rough gun. One half containing one trunnion is moulded in each half of the flask. The mould is then dried by heat, the two halves clamped and bolted together, and the whole lowered into the pit. It weighs 53 or 54 tons. The core barrel is a hollow cylinder of iron 17 inches in diameter, closed at one end, open at the other. It is about one inch thick and is grooved longitudinally or fluted, like a column in architecture, its entire length, the furrows being ½ an inch apart. Around this is wound a rope of the size of ordinary bed cord, and over this a layer of clay ¾ inch thick is evenly spread and the whole dried. The object of the grooving is to allow the free escape of gas. The rope prevents the clay from filling up these grooves. This core thus prepared is lowered into the mould, and maintained exactly in the centre by a heavy collar bolted down to keep it from rising. A copper pipe passing to the bottom of the core supplies the water: while another pipe opening into the top leads off this water after it has become hot in the core-barrel.

The furnaces are constructed on the reverberatory plan, the hearth inclining toward the fire. They are known as air furnaces, and depend on draft entirely. They were charged cold with second fusion Bloomfield pig iron; No. 4 receiving 39 tons, No. 5 and No. 6, 23½ tons each. No. 3 was charged with 18 tons and held as reserve. The fires were lighted in these furnaces at 4^h 15^m on the morning of Thursday, Feb. 11. The day was fine and the barometer high; the draft was therefore good and the iron was all in fusion at 11^h 30^m. Low iron, or that containing an excess of carbon, is soft and weak: high iron containing less carbon is harder and more tenacious, but it contracts more in cooling. Hence the iron in the furnaces was tested from time to time to ascertain when it reached the right point. At 12^h 24^m, the three furnaces were tapped simultaneously. The metal was conducted in runners to a pool near the pit, from the side of which, near the bottom, it passed in two runners to the gun mould, entering, not directly, but through side channels or gates, having branch gates inclined upward toward the axis, at intervals of 12 inches. The scene just at this time was grand. Three streams of liquid fire, throwing out most brilliant coruscations, after a course of fifty feet or more, fell into a sea of the molten metal, again to emerge in two others which ran to, and disappeared in the vast iron frame. Away down in

the gun-mould could be seen the boiling metal slowly rising toward the top. The moisture of the sand yielded up its hydrogen: the rope furnished carbonic oxyd; and the sticks with which the surface of the metal was constantly stirred added to the flame: until it seemed as though an abyss had opened into the internal fires of the earth. Water at a temperature of 36° F. had been admitted to the core-barrel before tapping the furnaces, and it then left at the same temperature, the flow being 30 gallons per minute. At $12^h\ 45\frac{1}{2}^m$, the mould was full and the flow from the furnaces was stopped; the entire time of casting being $21\frac{1}{2}$ minutes. At this instant, the water left the core barrel at 42°. At 4^m thereafter 52°; $8^m - 65\frac{1}{2}°$; $14^m - 81\frac{1}{2}$; $25^m - 91°$; and at $30^m - 91\frac{3}{4}°$. One hour after casting, this flow of water was increased to 60 gallons per minute. At two o'clock a collar was put on the flask and more metal was added to increase the length of the 'sinking head.' More effectually to retard external cooling, grate bars were placed near the bottom of the pit, around the flask, and the fire on them was lighted at $3\frac{3}{4}$ o'clock. The flow of water was continued till A. M., February 12. Then the core barrel was removed, after some little delay, at $2^h\ 45^m$. With very high iron it is deemed possible to cool the interior so rapidly as to fracture the exterior. As this iron was pretty high, it was not considered advisable to proceed as usual, that is to circulate water directly in the bore of the gun, but to substitute air therefor. A sheet iron pipe 8 inches in diameter was carried to the bottom of the bore and a stream of air driven continuously through at the rate of 2000 cubic feet per minute. This air commenced to flow at $2^h\ 57^m$ on the 12th, and continued uninterruptedly until the gun was cold. On the 19th at $3^h\ 30^m$ P. M. the air issued at the temperature of 70° F., the fire in the pit having been extinguished the night previous. On the 23d, the gun was stripped; i. e., the flask was removed from its surface. A solid cylinder of the metal for trial, 2 inches in diameter and 4 inches long, was taken out about two feet from the top. But in removal it fractured across the spongy portion, about three inches from the exterior. So that of the thickness of the gun $14\frac{1}{2}$ inches, $11\frac{1}{2}$ formed the interior shell. A second specimen was taken, 4 inches below the muzzle, that is 4 ft. 4 in. below the top of the sinking head. This on testing gave density 7·3028 and tenacity 28737. The iron was very uniformly mottled and appeared of excellent quality. On the 24th, the casting was still perceptibly warm at its lower end. The stream of air was therefore continued until the 25th. Then by means of two immense steam cranes, this huge gun, weighing 86 tons, was lifted from its pit, and prepared for the lathe. The casting was perfect. All these facts, therefore, indicate that 20-inch guns are as easily made as 15-inch.

The dimensions of this gun when finished will be as follows:—Total length over all, 20 ft. $3\frac{1}{2}$ inches. Length of bore 210 inches. Maximum diameter 5 ft. 4 inches. Diameter at the muzzle, $33\frac{1}{2}$ inches. Diameter of bore, 20 inches. Total weight, 112000 lbs. The weight of the shot, supposing it solid, would be 1000 lbs. A service shell of this size, $3\frac{1}{2}$ inches thick, would weigh 725 lbs.; a battering shell, $6\frac{3}{8}$ inches thick, 925 lbs. The charge of powder required would be about 100 lbs. Nine men could load it as easily as five now load the 15-inch gun. The living force of the service shell above mentioned, in crushing the sides of an

iron-clad, would equal that of *six ten-inch solid shot:* and that of the battering shell would considerably exceed that of *seven ten-inch solid shot.*

This gun being entirely experimental, Government only pays the expenses of manufacture. On all guns cast hollow, however, the patentees get one cent per pound royalty.

The casting of this gun took place under the supervision of Major Dyer, of the Springfield (Mass.) Armory; Major Rodman, of the Arsenal, Watertown, Mass.; and Capt. Benét, Inspector-in-chief of Ordnance, West Point, N. Y.: all of the Army. And there were present Capt. Aulick, of the Ordnance Bureau, and Capt. Berrian, Inspector of cannon and projectiles at this station, of the Navy. Capt. Goodenough of the Royal Navy, and the Marquis de Basse Court, of the Italian Navy, were among the distinguished spectators.

This immense Foundry is now carried on by Charles Knap, Esq. He has for his foreman Mr. Joseph Kaye, acknowledged to be the best gun founder in the country. G. F. B.

VII. BOOK NOTICES.

1. *First Outlines of a Dictionary of the Solubilities of Chemical Substances.* By Frank H. Storer. Part II.—The importance which we attach to Mr. Storer's work now in process of publication leads us to make some further observations on the second part which appeared a few months since. This portion of the work confirms the impression made by the first; it is characterized by the same pains-taking accuracy, and the same clear conception of the requirements of his subject.

This second part begins with convolvulinolic acid and ends with oxyd of tin; it embraces many large and important chemical groups, such as the cyanates, cyanids, fluorids, iodids, the ethylosulphates, hydrates, nitrates, oxalates and part of the oxyds. With respect to all of these, copious and minute information is afforded, derived from an exceedingly large number of sources, as is sufficiently evinced by the great number of references given. As a single example, we may remark that the solubility of nitrate of potash in various menstrua is illustrated by no less than sixty-three quotations from authors on the subject.

The advantages of a work like this are two-fold. For it not only aids the chemist by placing in an acceptable shape the information which he desires, but it will be found, in our opinion, to afford a decided stimulus to the completion of an exact knowledge on the subject to which it is devoted. It exposes, by a significant silence, the points which have been overlooked or neglected, or relative to which no observations have been made; thereby inviting active chemists to fill up these lacunes and complete our knowledge. Mr. Storer has moreover given very conscientiously his authority for by far the greater number of his statements, therein following the excellent example set by Leopold Gmelin; which is gradually becoming more and more generally imitated by chemical writers. This system is satisfactory in the highest degree both to the reader and to the authors quoted. To the latter, it aids in giving the just reward of their labors, that consideration and reputation which together with honest and hearty love for the study, is so often the only recompense that falls to the lot of the really scientific chemist. To the

reader, it is equally valuable, for in the case of conflicting statements it enables him at least to form some opinion as to which are most likely to be reliable, and as to the necessity of further investigation.

The book is indispensable to the chemical student. We feel the want of the third part, for the sulphates, phosphates and tartrates, etc., and shall welcome its appearance. M. C. L.

2. *Chambers' Encyclopedia: a Dictionary of Universal Knowledge for the People.* Illustrated. Philadelphia: J. B. Lippincott & Co. Edinburgh: W. & R. Chambers. 1861–1863. Vols. I–V, royal 8vo, pp. 828 each.—We have in a previous volume of this Journal noticed the commencement of this valuable publication. It has now reached the completion of the fifth volume, bringing the alphabet down to the letter L. It is constructed on the general plan of the Conversations-Lexicon of Brockhaus, and, like its great prototype, is characterized by variety, conciseness, and accuracy. The articles on scientific topics are numerous and remarkable for exactness and brevity. The error is nowhere committed of extending such notices beyond the proper limits of a dictionary of knowledge to the dimensions and scope of elaborate treatises. The spirit of the original 'Cyclopedia' of Ephraim Chambers —now more than a century old—has been revived by his namesakes in the present work, his original plan—very like that of the German Conversations-Lexicon—having been widely departed from in many similar works of subsequent date. By a liberal use of wood-cuts in the text the value of this Encyclopedia has been much increased. Such illustrations are used whenever the subject demands them, and they are generally of excellent quality. The work is printed from the English plates, and is published in cloth at $2.80, sheep $3.20, half turkey $3.60, and will be completed in seven or eight volumes.

3. *A Practical Handbook of Medical Chemistry;* by John E. Bowman, F.C.S. Edited by Chas. L. Bloxham, Prof. of Practical Chemistry in Kings College, London. Third American from the fourth London edition. Philadelphia: Blanchard & Lea.—Important additions have been made to the present edition, especially in the examination of urine by the volumetric methods, and for poisons in organic mixtures by a general systematic course of detection. Prof. Graham's methods by dialysis are also introduced, and the electrolytic detection of metals is revived.

4. *Dana's Manual of Geology.*—A revised edition of Dana's Manual of Geology has just been issued by the publishers (T. Bliss & Co., Philadelphia), containing, besides some other additions, a woodcut of the long-tailed Bird of Solenhofen, copied from the last December number of the Intellectual Observer (illustrating in that Journal an article by Mr. H. Woodward), and another of a new Insect from the Carboniferous rocks of Illinois.

OBITUARY.

Edward Hitchcock.—Professor Edward Hitchcock died at Amherst, Massachusetts, Feb. 27th, at six in the morning, aged seventy years and nine months. He was born at Deerfield, Mass., May 24th, 1793. Although enjoying limited advantages of early education he had the position of Principal of the Academy in his native town, from 1815 to 1818, during which time he also edited an almanac. In 1811, when only 18 years of age, he made observations on the comet and solar eclipse of that

year. His first geological paper, and in fact his first important contribution to science, was his "Remarks on the Geology and Mineralogy of a section of Massachusetts on Connecticut River," published with a map in the first volume of this Journal, and dated at Deerfield, Oct. 1817. From 1818 to 1825 he was the Pastor of a church in Conway, Mass., still pursuing his scientific studies as is evident from his papers, chiefly on mineralogy and geology, published in the first ten volumes of this Journal. He gave also, during this period, an account of Bailey's new method of longitude, immediately on its appearance, in a manner which shows him to have been master of the subject.[1] From 1825 to 1845 he filled the chair of Chemistry and Natural History in Amherst College, with whose history and prosperity his name is inseparably connected. In 1845 he was chosen to the Presidency of Amherst, retaining the duties of instructor in geology and natural theology. In 1854 he resigned the presidency, having during his discharge of its duties conferred the most substantial benefits upon the institution, rescued it from a state of depression and insolvency to one of comparative abundance and substantial endowment, and doubled the number of attending students. He retained until his death his favorite duties of the geological chair, as well as those of natural theology.

In the history of the Governmental Geological Surveys, Prof. Hitchcock's name must always hold a prominent place. It was by his suggestion that, in 1830, the State of Massachusetts added a geological surveyor to the corps charged with the preparation of a trigonometrical survey of that State. His first report on the Economical Geology of the State was published in a pamphlet of 70 pages, in 1832, with a geological map. In 1833 he made a full report on the whole subject, in a volume of about 700 pages, with an atlas of plates and a geological map. In 1837, under the governorship of Mr. Everett, he was commissioned anew to reexamine the geology of the State, which resulted at last, in 1841, in a final report in two quarto volumes of 840 pages, with 56 plates and 82 wood-cuts. This was independent of the separate reports on zoology and botany made by the able naturalists who were associated with him. Several other reports followed, on Surface geology, on the Hematite of Berkshire, &c., and lastly the final report on the Ichnology of New England, the result of more than twenty years of study of an intensely interesting but difficult subject. This report was published by the State at an expense of about $5000. In 1856, when borne down by severe infirmity, he had still the courage to undertake, with his two sons, the geological survey of Vermont, which was brought to a successful issue notwithstanding that, as he says in his "Reminiscences," the Legislature "starved them out," the final report of about a thousand pages having appeared in 1862. His last paper, "New facts and conclusions respecting the Fossil Footmarks of the Connecticut Valley," was published in July of 1863, (our last volume, p. 46,) and we well remember the conviction he then expressed, that it was his last production—although it was so much his habit to despond and still labor on, that we felt it not unlikely we should again welcome his well known signature to our pages. Fortunately his strength held out for the completion of his "Reminiscences," the preface of which bears date Sept. 1st, 1863. In that personal narrative, while dealing primarily with Amherst College and his labors in her

[1] This Journal, vol. ix, p. 107.

behalf, we find a mirror of his scientific life and labors. How much he was the servant of all work, in his position of President, appears from the following passage:

"My epistolary correspondence in the Presidency was peculiarly onerous. I had previously been so much of a *jack at all trades* that I had laid myself open to inquiries and assaults from all classes. The same mail (and I hardly exaggerate the literal fact,) might bring inquiries about some point in the theory of temperance—how to employ garnet in making sand-paper—how to reconcile the imputation of Adam's sin with our sense of justice—where to find the best beds of sulphate of baryta—whether I would like to exchange or buy shells, minerals and fossils—how cheaply an indigent young man can go through the college and with what helps—whether I know of any one who will make a good teacher of a common school, an academy, or a professor in a college—or any one to supply a pulpit—what I think of a new theory of drift, or of latent heat—or new views of the relations of geology to Moses—or a new poem—or a new work—all of which are sent and an answer requested, if possible, by return mail."

We can do no justice to such a life as Prof. Hitchcock's in a brief notice. Earnest, simple, and sagacious, indefatigable under all discouragements, his clear, firm grasp of truth sustained and raised him above all difficulties, and has secured him an honored name in science. And this is not all, for science with him was ever made tributary to Christian truth and effort.

PLANA.—Baron GIOVANNI PLANA, the most renowned of Italian astronomers and mathematicians, died at Turin, on the 20th of January last, in his eighty-third year. Few men have left more enduring monuments of industry and power in the difficult branches to which he devoted his life, than Plana. The very last volume of the Transactions of the Turin Academy received here contain no less than seven elaborate memoirs from his pen. His theory of the moon is perhaps his most celebrated memoir. At the last session of the Turin Academy—the same which received the news of his death—a second paper was presented from him on the cooling of the heavenly bodies and an analytical expression of the sun's heat.

HEINRICH ROSE, the illustrious chemist, died at Berlin, on the 28th of January, at the age of 69 years, having filled the chair of Chemistry in the University of Berlin for more than forty years. He was a pupil of Berzelius, at Stockholm, in 1819. His treatise on Analytical Chemistry has been translated into French and English, and for a long time was almost our sole authority. *Poggendorff's Annalen* contained nearly all his papers, and scarcely a volume of that important journal for forty years past is without contributions from his pen. Rose was in private life one of the most gentle and excellent of men. Thus in two months has the University of Berlin lost two of her most illustrious men, Mitscherlich and H. Rose.

CAPPOCCI—the learned director of the Observatory of Capodimonte (Naples), died on the 6th of January, of an affection of the heart, at the age of sixty-six years.

Notices of new publications received are necessarily deferred for want of space.

THE

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[SECOND SERIES.]

ART. XXVII.—*On the Diptera or two-winged Insects of the Amber-fauna.* (*Ueber die Diptern-fauna des Bernsteins*): a lecture by Director LŒW, at the meeting of the German Naturalists in Kœnigsberg, in 1861.[1]

OF all the organic remains of former geological periods, those enclosed in amber are the most remarkable for their state of preservation, which is such that they admit of the most complete investigation. While under other conditions smaller and more delicate animal organisms have either almost or quite disappeared, in this case it is the very reverse, and hence the amber-fauna has an extraordinary richness in species, so that both for its beauty and abundance it invites to an investigation which promises the most interesting results. The objects for such investigation however are so various, that a division of labor is required. Induced by my deceased friend, Behrendt, I commenced the study of the Diptera preserved in amber nearly seventeen years since, and have continued it, not without unavoidable interruptions, up to the present time. A rich supply of material for this study has been supplied from various sources, and with a liberality which remained undiminished, in spite of the unexpected length of time required by the investigation. The principal por-

[1] We owe this translation of Director LŒW's interesting Lecture on the Amber-fauna Diptera to Baron OSTEN SACKEN, so well known for his important contributions to the study of American entomology. The many points of interest which this lecture affords to American naturalists will render the translation peculiarly acceptable to English readers who have not access to the original. The author himself has kindly furnished the notes, containing lists of species common to Europe and North America, and which, not being found in the original, are here published for the first time.—(*Note by the Editor.*)

tion of this supply is the entire Behrendt collection of Diptera in amber, to which that of Aycke has been added; also rich contributions from the collection of H. Menge, of Danzig, from that of the Physico-economical Society of Kœnigsberg, as well as from the Thomas collection in the Royal Mineralogical Museum at Berlin, without special mention of valuable contributions from individual collectors, who have with praiseworthy liberality sought to advance the aims of science.

The investigation of this rich supply of material has, up to this time, made known about 850 species of Diptera in amber, and these all belong to the division of the *Diptera proboscidea*, while, so far, not a single species of the *Diptera eproboscidea* has been found to occur. Of these 850 species, however, there are only 656 in so complete a state of preservation that their specific characters can be determined with absolute certainty. These are distributed over 101 genera, of which 50, with 395 species, belong to the *Diptera nemocera*, and 51, with 261 species, to the *Diptera brachycera*.

In the case of the latter, the chemical decomposition of their larger bodies, the more vigorous resistance which they have made to their entombment in the yet soft resin, the slighter development of their antennæ and legs, (organs which furnish such important characters for the ready distinction of the *Diptera nemocera*,) and still more, the few characteristic points in the neuration of the wings in most of them, for the distinction of species, of genera, and even of families, all conspire to render the proportion of fragments quite useless for exact determination much greater among the *Diptera brachycera* than among the *Diptera nemocera*. If such specimens could be turned to account, the above mentioned proportion of species would be greatly increased on the side of the *Diptera brachycera*.

The 50 genera of *Diptera nemocera* are distributed over all the families which have been formed for the living species, with the single exception of the small family of the *Blepharoceridæ*, if this is not united with that of the *Simulidæ*. The family of the *Mycetophilidæ* is the richest of all the others, both in species and in numbers; the family of the *Culicidæ* is the poorest.

From what has been said above, as to the frequently imperfect preservation of the *Diptera brachycera*, it can easily be understood that for many of the species found in amber, a definite place in the systematic arrangement can be assigned only with great difficulty. This is true especially for those families which have generally been included under the name of *Muscariæ*, that is, all of the families and genera which Meigen, in his arrangement, places after the genus *Myopa*. For this reason, it is absolutely necessary to distinguish those families of the *Diptera brachycera* whose occurrence in amber is beyond a doubt, from those which are more or less doubtful. The families which are

now known certainly to occur in amber, are the following seventeen: *Xylophagidæ, Tabanidæ, Leptidæ, Cyrtidæ, Asilidæ, Thereuidæ, Bombylidæ, Syrphidæ, Pipunculidæ, Hybotidæ, Empidæ, Tachydromidæ, Dolichopodidæ, Helomyzidæ, Micropezidæ, Diopsidæ* and *Phoridæ*. The families whose existence in amber is tolerably well established, are the following ten: *Myopidæ, Tachinidæ, Dexidæ, Muscidæ, Anthomyidæ, Sciomyzidæ, Sapromyzidæ, Ephydrinidæ, Drosophilidæ* and *Oscinidæ*. As families, which seem not to be represented in amber, we may name six: the *Sarcophagidæ, Lonchæidæ, Heteroneuridæ, Opomyzidæ, Piophilidæ,* and *Geomyzidæ*. Finally, there are eighteen families of which it is perfectly certain that not a single species has been found in amber, namely: *Stratiomyidæ, Acanthomeridæ, Mydasidæ, Hirmoneuridæ, Scenopinidæ, Platypezidæ, Lonchopteridæ, Œstridæ, Cordyluridæ, Psilidæ, Ortalidæ, Trypetidæ, Phycodromidæ, Sepsidæ, Agromyzidæ, Phytomyzidæ, Asteidæ* and *Borboridæ*. Of the families above named, the *Dolichopodidæ* far exceed all the others both in the number of species and of individuals; next to this come the *Empidæ*, as far as the species are concerned, but the number of individuals is far less. The families represented by only one species, found only once, or at most twice, are the *Tabanidæ, Bombylidæ, Pipunculidæ* and *Diopsidæ*.

We have thus given what indeed may be considered as only a very general sketch, but yet a complete and faithful representation of the knowledge which, up to this time, we have been able to obtain of the Diptera of the Amber-fauna.

The Diptera in amber I consider as representing a fragment of a district fauna of the amber-period, which however owes its peculiar character to special local conditions.

The manner in which amber now occurs will very well allow us to assume that perhaps the bits found in any one place, or that at least those found in different places, may have been derived from localities quite far removed from each other. The known occurrence of enclosures which appear to be analogous to recent species of very different climates, seems to favor such a supposition. The proof of its correctness by the discrimination of the species, enclosed in amber derived from different localities, has so far been impossible, since only in a very few cases have we been able positively to ascertain the locality where the insect-bearing specimens came from. We had therefore, in order to obtain the desired result, to adopt a different mode of investigation.

If the species *a* is found enclosed in the same piece with the species *b*, while *b* has been found to occur in another piece together with *c*, we may presume that they belong to the same district-fauna. I have therefore devoted especial attention to those pieces of amber which contained several species, and have endeavored,

from their examination, to form a catalogue of the species which, under the above supposition, might be considered as belonging to the same district-fauna. Some very beautiful pieces of amber, containing each from ten to twelve species of Diptera have greatly aided me in this investigation. But among most of the amber collectors the unfortunate fashion prevails of dividing the larger pieces, containing several specimens, into smaller fragments in order to show each one by itself and to make a more convenient arrangement in the museum. The loss to a true scientific investigation of the Amber-fauna by this mode of proceeding has been so great that I cannot use too strong language in protesting against it. Although the catalogue thus formed does not by any means embrace all the species, it is yet comprehensive enough to enable me fully to confirm the supposition that the Diptera which are found in Prussian amber belong to one and the same district-fauna.

The assumption that the Amber-diptera represent a fragment only of such a district-fauna, dependent upon special and yet uniform local conditions, must be considered as established, if the composition of this fauna evidently suggests coincident conclusions as to the nature of these local conditions; or, in other words, if it can be proved that the Dipterous fauna of the amber is composed of the different families, just in the same manner as families of recent Diptera would enter into the composition of a fauna, subject to certain local conditions.

Now, the composition of the Dipterous fauna of the amber is indeed precisely such, as forcibly to suggest some conclusions about the nature of the localities in which it flourished and in which the amber now enclosing it was formed. The great prevalence of the *Diptera nemocera*, both in the number of species, and still more of specimens, affords us in this respect an important indication. Most of these species are but poor flyers, never rising to a great height, preferring moist places, sheltered from the wind, and appearing in vast numbers only under such circumstances. The idea which the especial abundance of the *Diptera nemocera* has suggested, as to the nature of the locality in which they once lived, is fully confirmed in other ways. As at the present day, the more delicate species of *Empidæ*, *Hybotidæ*, and *Tachydromidæ*, seek with peculiar preference the hovering places of the *Diptera nemocera*, on the borders of ponds grown up with vegetation, or the shelter of the denser forests, so too they are found in abundance in amber. Of the *Dolichopodidæ*, those species are quite absent which live principally upon the water, or on water plants, while of those more active forms which swarm in open spots, there are only a few scattered representatives; on the contrary, of those genera whose species at the present day are found lurking for their prey in swarms on the

trunks of trees, sheltered from the wind, the number of species, and still more of individuals, is quite considerable. The abundance of those Diptera whose larvæ live in rotting wood, and the countless swarms of *Mycetophilidæ*, bear testimony of the dampness of the locality and of the predominance of fungus-vegetation. Other Diptera, whose larvæ live in standing or slowly flowing waters, show that such were not wanting, while the larvæ of some species, if the analogy with those now living does not fail, must have had their abode in more rapid currents.

If the presence of the Diptera just enumerated furnishes positive testimony as to the local conditions, so does the great rarity or total absence of other families of Diptera, afford a hardly less important negative testimony to the same effect. It is remarkable enough with what absolute distinctness all of those Diptera are wanting in amber which prefer open swarming places, exposed to the sun, or select arid spots. So of all the genera of *Anthracidæ*, there has been found but a single species, and that has been met with only twice. Of *Asilidæ*, of which only a few decidedly prefer to dwell in places such as have been just described, four species have been found. The very rare occurrence of the *Dexidæ*, the *Muscidæ*, and the *Tachinidæ*, as well as the limitation of the *Syrphidæ* to a very narrow series of forms allied to *Xylota*, appears also to depend upon the preference which the majority of the species belonging to these families, have for open, sunny localities, abounding in flowers. Their greater strength and power of flight may have rendered their escape possible, when species not so well provided would have certainly been enveloped, but this difference is not sufficient ground for their unfrequent occurrence in amber, if we assume that the species of these families were already abundant in the Amber epoch, while under the same supposition we could explain it by the controlling influence of special local conditions. The numerous and very varied forms of the *Cecidomyidæ*, whose species are strictly confined each to its peculiar plant, teach us that the flora was one rich in species; this decidedly removes the supposition of the exclusive presence of extensive coniferous forests and renders it certain that leaf-bearing phanerogamous plants, if not abundant in numbers, were at least rich in species, while it is by no means apparent that they all had the arborescent form. Next to the *Cecidomyidæ*, the species of no other family are so intimately connected with particular plants as those of the *Trypetidæ*, whose larves have an especial preference for the *Synantheræ* (*Compositæ*) as an abode. These are entirely wanting in amber. From this to pronounce upon the total want, or even the rarity, of *Synantheræ* in the Amber period, would be a too rash conclusion; moist and shady places are avoided by these insects, who seek the plants, which are to be the residence

of their progeny, in open and sunny spots, and hover about these plants, or at least in their neighborhood, with great pertinacity. Thus their absence from amber is only one more striking testimony to the above-mentioned conditions of the locality in which the Amber-diptera lived.

These minute beings of a long by-gone age, preserved to us in the form of mummies, afford us also some glances into the scenes of the animal life of that time. That the warfare between those of their own kind, still going on in our days, had even then begun, is shown by the swarms of *Leptidæ*, *Empidæ*, *Hybotidæ*, *Tachydromidæ* and *Dolichopodidæ*, which prey upon other Diptera. That this war was even then declared against other orders of insects, is seen from the presence of powerful *Asilidæ;* that there was a war waged against them, in which too they were not victors, is learned from the number of spiders found with them. An insect of the genus *Silvius* (*Tabanidæ*), whose female certainly could not have failed to quench her thirst for blood, shows that some of the larger mammals must have lived there, while the complete absence of the genera *Stomoxys*, *Scatophaga* and *Borborus*, as well as of all the *Œstridæ*, does not render it probable that they were in very great numbers.

We behold then the Diptera, now entombed in amber, in their once living swarms, in strife among themselves, at war with others, sometimes conquerors, sometimes vanquished, in a damp region, where fungi grow abundantly, sheltered from the wind by thick forests, surrounded by a phanerogamous flora, rich in species; and we involuntarily ask, In what sort of a climate lay this paradise for long-legged gallinippers and impudent gnats?

If we had any reason to consider the now extant amber-diptera as representatives of a district fauna in general, instead of taking them merely for specimens of a fragment of such a fauna, a fragment dependent on, and limited by local influences, our conclusions about the climate of that district would be essentially different. The prevalence of the *Diptera nemocera*, as to the number of species as well as individuals, the great rarity of *Asilidæ*, and still more of the *Bombylidæ*, the absence of all *Nemestrinidæ*, etc., would undoubtedly have indicated a climate somewhat colder than the present climate of Prussia; the appearance of some forms, reminding of warmer climates, would in such a case have been but of little importance, as even now the higher latitudes harbor some forms of this kind. I believe I have proved sufficiently that the local influences which limited the composition of the amber-fauna, have to be taken into account in drawing our conclusions. Then, the prevalence of the *Diptera nemocera* will lose the importance which it otherwise would have had; for also in present times, localities of the above indicated description, even in much lower latitudes, show this

prevalence in the same degree; at the same time, the presence of a number of Diptera, closely related to some southern species, will gain so much the greater importance, since the rarity of their occurrence in amber merely proves their rarity in the specified local conditions, without excluding the possibility of their common occurrence in other localities as well as of the occurrence of many other species not preserved in amber. The following species may be named as indicative that the climate of the Amber period was very probably somewhat, although not very much, warmer than the present climate of Prussia: 1. *Styringomyia gracilis* and the species of *Diplonema*, the close relatives of which occur in copal. 2. Species of *Plecia*, closely allied to those occurring in warmer latitudes. 3. *Sphyracephala*, a close relative of *Sphyracephala brevicornis*, Say, common in the middle and southern of the United States, the only living representative of the genus as yet known. 4. A species of *Corsomyza*, the living representatives of which belong to the Cape of Good Hope; they show, however, considerable structural differences from *Corsomyza crassirostris*, enclosed in amber. 5. Several *Cyrtidæ*, of the section *Cyrtina*, more numerously represented now in countries the temperature of which is at least equal to that of the southern peninsulæ of Europe.

An especial interest is afforded by the comparison of the Amber-diptera with the fossil Diptera of the tertiary period, found in other localities. I have been able as yet to subject to a close and careful scrutiny only the fossil Diptera found near Radoboj in Croatia. The collection of these Diptera belonging to the Imperial Mineralogical Institution in Vienna contains the types of the species determined and described by Professor O. Heer. The result of my researches is, that the Diptera of Radoboj afford only a very indistinct insight into a still more localized fauna; that there is not a single genus among them which does not likewise occur in amber; that although some species from Radoboj are pretty nearly allied to species enclosed in amber, the identity of such species cannot be proved at present, and probably never will be proved, on account of the difficulty of comparing specimens in so very different conditions of preservation. Of the more striking forms found in amber, those especially which do not belong to the European fauna, as far as known at present, none had been discovered in Radoboj, with the single exception of some species of *Plecia*.

I will proceed now to the comparison of the Amber-diptera with those of the present age. If it were possible to compare the complete fauna of the Amber period with the now living Dipterous fauna of the globe, and, by such a comparison, to find out which of the families and genera have died out, or at least have become scarcer in the number of species, and in which the

number of species has increased, or even what new forms have been added to the previously existing ones, such a comparison would of course afford the highest interest. But, unfortunately, such an attempt is impossible, on the one side because of the as yet very imperfect knowledge of the now living Diptera, on the other, because what we know of the Amber-Diptera is but a fragment of a district fauna. In confronting, therefore, both faunas, I will by no means try to discover and to establish differences between them of the above indicated kind, which would be a useless attempt; my only aim will be to refute as erroneous certain conclusions as to the existence of such differences. Among such conclusions I will especially advert to the two following: *first*, that in the Amber period the relative proportion of the *Diptera nemocera* to the *Diptera brachycera* was greater than now; *second*, that during the Amber period the limit between the two sections of the Diptera was less definite, more obscured by intermediate forms, and that it became better defined only at a later epoch, through the disappearance of those intermediate forms.

The reasons why I do not adopt the former of these conclusions result from my foregoing deductions, and it is unnecessary to dwell upon them any longer. But I have to make some remarks about the other conclusion, inasmuch as formerly I was myself not disinclined to favor it, although I reject it now as founded upon erroneous premises. For a long time students of systematic Dipterology were wont to look upon the boundary line between those two sections, with regard to the living fauna, as a very well defined one, excluding any intermediate forms. My first researches among the Amber-diptera brought about the surprising discovery of two species, showing a distinct transition between the two sections. I founded two new genera upon them, one of which I called *Electra*, in allusion to the Greek word for amber, and the other *Chrysothemis*, to indicate its close relationship to *Electra*. Both combine the many-jointed antennæ of the *Diptera nemocera* with the general structure of the *brachycera*. As long as no similar forms among the living Diptera from all parts of the world had been discovered, there was indeed some reason to suppose that the limit between the two sections was sharper now than in the Tertiary period, although our very incomplete knowledge of the living Dipterous fauna required some caution in drawing this conclusion. This caution was justified subsequently by the discovery of a North American species, published by Mr. Haliday under the name of *Rachicerus fulvicollis*, a species which not only forms a most decided transition between the two principal sections of Diptera, but shows even the closest relationship with *Electra* and *Chrysothemis*. My own studies of the North American fauna have

made me acquainted with three other intermediate forms of this kind, two from the United States and one from Cuba. These species also belong to the relationship of *Electra*, *Chrysothemis* and *Rachicerus*, although they cannot be referred to either of these genera, so long as their present distinction, based upon the structure of the antennæ, is maintained. The great diversity which they show in the structure of that organ, by the conformation of which they are distinguished from the whole tribe of the *Diptera brachycera*, is striking, but not without analogies. The sections of the *Diptera nemocera* and *brachycera* are therefore connected by intermediate forms in our times, just as they were so in the Amber period, only these intermediate forms being foreign to the European fauna, were discovered in amber first, and afterward among the living insects.

That among the amber Diptera there are many genera of which no living representatives are as yet known is beyond question; I have had occasion to state this fact more in detail in my "Observations on the Dipterous fauna of the Amber," published in 1850. A part only of these genera owe their existence to the necessity of establishing for these fossil species generic distinctions based upon slighter plastic characters than those usually admitted for the separation of living species, and have therefore less claim to be taken into consideration here. Another portion consists for the most part of very striking species, easily distinguished from all the known living genera. But this circumstance does not justify the conclusion that such Diptera are really strangers to the living fauna of our age; on the contrary, the results already obtained by the heretofore very incomplete investigations, authorize the supposition that these genera may yet be found among living species. Several of these interesting genera have already their little history. May I be allowed to mention here some facts of this kind.

One of the most curious discoveries made in amber is a remarkable genus, situated near *Cænomyia* and for which I have proposed the name of *Arthropeas*, on account of its peculiar subuliform antennæ. After having found *Arthropeas nana* in amber, I received a closely allied species from Eastern Siberia, *A. Sibirica m.*, and now I possess in *A. Americana m.*, a species from the United States which is even somewhat more nearly related to *A. nana*.

The genus *Bolbomyia*, two species of which occur in amber, was remarkable for the difficulty of assigning a suitable location for it in the system, as among all the living Diptera no closely allied genus could be found. Of this genus I likewise possess now a North American species, unfortunately in a single specimen, the state of preservation of which does not allow a close comparison.

Diplonema, remarkable for the elegant structure of its antennæ, is one of the most striking genera of *Psychodidæ* found in amber; *Styringomyia*, a genus of the *Tipulidæ*, has a very peculiar neuration of the wings; both genera when I discovered them in amber were new. I was not a little surprised therefore when I found specimens of both genera together, enclosed in a lump of copal. Unfortunately it was not possible for me to ascertain the country where this piece of so-called East Indian copal came from, although I still hope that a well-preserved beetle, contained in it, may help to solve this question.

Among the amber Diptera I also found three species of a Tipulideous genus, which I called *Toxorhina;* it is remarkable for its long, almost filiform, stiff proboscis, for the peculiar structure of its oral organs, and for the abnormal neuration of its wings. Later, I became acquainted with a living representative of this genus in *Toxorhina fragilis* from Jamaica, and still later I was led to recognize that Westwood's genus *Limnobiorhynchus*, founded upon a Canadian and a Brazilian species, was, if not identical, at least very closely related with *Toxorhina.*

Another very remarkable genus among the number of the *Tipulidæ* occurring in amber, is the new genus *Macrochile.* A closely allied genus was recently described by Baron Osten Sacken, in the Proceedings of the Academy of Natural Sciences of Philadelphia, under the name of *Protoplasa.*

These instances, which could be increased by many others, will be sufficient to prove that it would be premature to conclude from the presence in amber of a number of genera, the living representatives of which have not yet been found, to the non-existence of these genera in the fauna of the present epoch.

The result therefore to be drawn from the foregoing facts and from the considerations connected with them, is in general of a rather negative nature; and this result is, that the facts in our possession do not justify any conclusion as to the existence in the Amber period of forms totally different from those now living in any important parts of their organization—or, to adopt a more positive mode of expression, it seems extremely probable that the generic types which existed in the Amber period, have been preserved down to our time. The question whether the number of generic types has been perceptibly increased since the Amber period cannot be discussed at all, as we possess but a small fraction of the fauna of that time.

If the generic types of the Diptera of the Amber period have thus been preserved to our time, the question naturally arises whether this is not also the case with the specific types, if not all, at least some of them. The general impression produced by the amber Diptera, even in a cursory examination, has so little of the character of novelty in it that we at once feel disposed to

raise this question and to proceed to the comparison with living species. Since the very beginning of my researches, that is, about seventeen years ago, I have very closely pursued this comparison. I early found that some of the species enclosed in amber are not only closely allied to living species, but that they are surprisingly like them, and several such species, (*Mochlonyx atavus* with *M. velutinus*, *Diplonema longicornis* with *D. eucerus*, *Styringomyia gracilis* with *St. pulchella.*) were already at that time noticed by me. Their number has since considerably increased. At the same time however, with the acquisition of better specimens, or of such as allowed a closer scrutiny of parts important for the discrimination of species, it became apparent that slight differences could always be discovered, preventing the assumption of the specific identity of amber Diptera with the living species most closely resembling them.

Those acquainted with the extreme difficulty attending, in many cases, the discovery of definite plastic characters for the discrimination of undoubtedly different species of living Diptera, will justify me if I attach less importance to the result of a single comparison of a fossil species, contained in amber, with an extremely resembling living one, than to the general average of the results of such comparisons. And this is, as already noticed above, that with the increase in quantity as well as in quality of materials for comparison, the differences which could be traced became gradually more definite than they were before, with poorer materials. Thus, not only do we not possess any sufficient proof of the identity of any one species, contained in amber, with a living one, but the results heretofore obtained render it extremely probable that a still greater increase of materials for investigation will enable us to discover specific distinctions even in the few cases which appear as yet doubtful.

Nevertheless the relation between the amber Diptera and the living species so closely resembling them is a very peculiar one. It consists for the most part chiefly in a somewhat different shape or a different relative size of one or several parts of the body, the structure of the whole and the shape of the other parts being most remarkably similar. The relationship, therefore, between such species is so strikingly close, that it naturally suggests the idea of a genetic connection, and maintains it against all possible theoretical objections. The impression that the living species, connected by such a close link of relationship to some amber Diptera, are not new additions to the number of old species, but are so to say, the transformed old species, is in my opinion irresistible to any unprejudiced observer.

The researches on the geographical distribution of the living species so closely related to some species enclosed in amber, lead to a very remarkable result. The gradual development of this

result in the course of my researches took place as follows. It appeared at first that the living species of the indicated kind were scattered irregularly and at random over all the parts of the globe. Further inquiry not only increased the number of such related couples of species, but allowed also very frequently to replace the living species of some previously discovered pair by some other, still more closely allied to the fossil one. The further the research was pursued in this direction, the more it became evident that the living species of these pairs have a very definite geographical distribution, as being gradually eliminated from the other parts of the world, they tended more and more to concentrate in Europe, and in a much higher degree in North America.

I readily acknowledge that my researches have necessarily been influenced by a purely personal coëfficient, which has to be taken into account, in order to establish the absolute value of the result obtained. This personal coëfficient consists in the numeric proportion of the living species from different parts of the world, which could be subjected to comparison, as well as in the more or less complete knowledge I had of the Dipterous faunæ of the different continents. The European Dipterous fauna is naturally the best known to me; next comes the North American fauna, which I know better than that of all other extra-European countries, excepting perhaps that of the Cape, as I possess from that region more than 800 species, collected within a comparatively limited territory. It is therefore unquestionable that the result obtained by me requires a correction, before it can have a claim to an absolute value. But should I even introduce this correction in the highest measure admissible, still enough will be left to enable me to assert with the utmost certainty that those among the living Diptera which most closely resemble the amber Diptera, abound in a most prevailing degree in North America and especially between the latitudes of about 32° to 40°; that a more limited number belong to Europe, and that, among the Diptera of the other parts of the world, heretofore none can be pointed out which stand to amber Diptera in the same relation of extremely close resemblance, as some European and North American species, and only very few to which some amber Diptera are more allied than to any other known living species.

The facts just explained become especially striking through the circumstance that those genera of amber Diptera, which do not occur in Europe, and which for this reason attracted more attention from European students, were in part discovered in America, and are in part replaced there by closely allied genera. With regard to this, I will remind only of what has been said above on the genera *Diplonema*, *Toxorhina*, *Styringomyia*, *Elec-*

tra, *Chrysothemis*, *Arthropeas*, *Bolbomyia* and *Sphyracephala*. The contrast between the close relationship of the North American Diptera with those of the amber on one side, and on the other the almost absolute absence of any such connection between the amber fauna and the living Dipterous fauna of the other parts of the world, this contrast is strikingly illustrated by the fact that among more than 800 species from the Cape closely scrutinized by me, there was not a single one which showed any remarkable degree of proximity to species contained in amber. The species of *Corsomyza*, at home in that region, are without exception the only ones which are represented by a Dipteron in amber, more allied to them than to any other kind at present known. We may therefore safely adopt as a final result of the researches made by us, and one that will probably be never controverted, that the amber Diptera stand in a much closer relation to the North American and to the European Diptera, than to those of any other fauna. This relation proves to be, in Europe as well as in North America, identical in its nature, and to any observer, unprejudiced by theories, irresistibly suggestive of a causal connection; it only differs in degree—the relation with the North American fauna being so much richer in points of contact, and therefore so much closer, than that with the European fauna.

This peculiar double relationship of the amber Diptera with the Diptera of North America and of Europe, two parts of the world separated by an ocean, led me to a closer comparison between the faunas of these continents, the results of which comparison I intend to submit in a detailed report on some other occasion. However, as these results have some connection with my researches on the amber Diptera and contribute to complete the sketch of the relation between the latter and the living species, I may be permitted to encroach a little longer upon the patience of my hearers, and to explain to them, omitting all detail, the progress of this new research and the principal facts elicited by it.

The comparison of the North American Diptera with the European ones was rendered possible to me, on a very extended scale, through the study of the collections of Baron Osten Sacken; this comparison showed a surprisingly large number of species common to both continents.[2] Besides these species,

[2] As such species, common to both continents, I can name with certainty and from personal investigation, the following: *Anopheles maculipennis* Meig., *Anopheles quadrimaculatus* Say (=*pictus* Lw), *Anopheles nigripes* Staeg., *Tanypus choreus* Meig., *Ceratopogon lineatus* Meig., *Cecidomyia destructor* Say (=*funesta* Motch., = *secalina* Lw.), *Scatopse atrata* Say (= *recurva* Lw.), *Scatopse notata* Linn., *Aspistes borealis* Lw., *Rhyphus fenestralis* Scop., *Rhyphus punctatus* Meig. (= *marginatus* Say), *Cœnomyia ferruginea* Fab. (= *pallida* Say), *Sargus viridis* Say (=*frontalis* Lw.), provided the specimen, communicated to me as European, really belonged to the old world, *Eristalis æneus* Scop. (= *sincerus* Harris), *Imatisma posticata* Fab. (= *cimbiciformis* Fall.), *Syritta pipiens* Linn., *Xylota pigra* Fab. (= *ha-*

absolutely identical and showing no difference whatever, a large number of species has to be recorded, which, if they had been found in Europe, would certainly have been considered only as slight varieties of other well-known European species, as their only deviation merely consists in a slight difference of coloring; but this difference being a very constant one, it becomes extremely difficult to decide whether such species should be considered as specifically distinct from the corresponding European species, or as identical with them.[3] A third, not less numerous category of species, shows, besides these slight but constant differences in coloring, some very insignificant plastic discrepancies; for instance, in the size, in the length of the hairs on the body, in the relative length of the wings or the legs to the whole body, etc., differences which, in order to be brought to light, sometimes require the comparison of a whole series of specimens.[4] A fourth

matodes Fab.), *Platychirus granditarsus* Först., *Brachyopa ferruginea* Fall., *Scenopinus fenestralis* Linn. (=*pallipes* Say), *Scenopinus lævifrons* Meig., *Dolichopus brevipennis* Meig., *Dol. plumipes* Scop., *Dol. discifer* Stann., *Scellus spinimanus* Zett., *Psilopus pallens* Wied. (=*albonotatus* Lœw), *Oestrus bovis* Fab., *Cephalomyia Ovis* Linn., *Gastrus Equi* Linn., *Melanophora roralis* Linn., *Pollenia rudis* Fab., *Musca domestica* Linn., *Cyrtoneura meditabunda* Fab., *C. stabulans* Fall., *Mesembrina resplendens*, *Stomoxys calcitrans* Linn., *Anthomyia diaphana* Wied., *Anthom. stygia* Meig., *Aricia morioides* Zett., *Hylemyia Angelicæ* Scop., *Hydrotæa dentipes*, *Hylemyia urbana* Meig., *Homalomyia canicularis* Lin., *H. subpellucens* Zett., *H. manicata*, *H. scalaris* Fab., *Hydrotæa armipes* Fall., *Ophyra leucostoma* Wied., *Lispe uliginosa* Fall., *Scatophaga squalida* (=*S. furcata* Say?) *Scatophaga stercorea* Lin., *Cordylura hircus*, *Sapromyza lupulina* Fab., *Scyphella flava* Linn., *Lauxania cylindricornis* Fab., *Lauxania frontalis* Lw., *Psila bicolor*, *Sciomyza nana* Fall., *Sciomyza obtusa* Fall., *Sciomyza albocostata* Fall., *Dryomyza anilis* Fall., *Blepharoptera iners*, *Ortalis vibrans* Linn., *Ortalis cana* Lw., *Piophila Casei* Linn., *Piophila nigriceps* Meig., *Piophila petasionis* R. Desv., *Heteroneura albimana*, *Borborus equinus* Fall., *Drosophila ampelophila* Lw., *Dros. transversa*, *Dros. graminum*, *Stegana nigra* Meig., *Stegana hypoleuca* Meig., *Dichæta caudata* Fall., *Dichæta brevicauda* Lw., *Scatella quadrata* Fall., *Scatella Stenhammari* Zett., *Ochthera mantis* Deg., *Ilythea spilota* Hal., *Melophagus ovinus* Linn., *Olfersia Ardeæ* Macq., *Hippobosca equina* Linn.

Besides a great many other species, the occurrence of which on both continents is recorded with less certainty, the following European species are found in Greenland, according to Stæger's trustworthy statements:—*Diamesa Waltlii* Meig., *Chironomus byssinus* Meig., *Chironomus aterrimus* Meig., *Chironomus picipes* Meig., *Trichocera maculipennis* Meig., *Sciara flavipes* Meig., *Calliphora erythrocephala* Meig., and *Phytomyza obscurella* Fall.

[*Rhipidia maculata* M. and *Symplecta punctipennis* may be also added with certainty.—O. SACKEN.]

[3] As instances of such species may be recorded here: the North American *Subula pallipes* Lœw, and the European *S. marginata* Meig., *Chrysotoxum* sp. indescr. and *Chrysotoxum bicinctum* Linn., *Tetanocera pictipes* Lœw, and *T. Umbrarum* Linn., *Tetanocera saratogensis* Fitch and *T. Pratorum*, Fall., *Hemerodromia valida* Lw. and *H. Frigelii* Zett.

[4] Here may be named: *Bombylius fraterculus* Wied. and the European *B. major* Linn.; *Chrysotoxum* sp. indescr. and *Chrysotoxum fasciolatum* Deg., *Helophilus* sp. indescr. and *H. frutetorum* Fab., *Lucilia* sp. indescr. and *L. cæsarion* M., *Cyrtoneura* sp. indescr. and *C. assimilis* Fall., *Gymnosoma par* Walk. and *G. rotundata* Linn., *Cordylura* sp. indescrip. and *C. pudica* Meig., *Allophyla lævis* Lw. and *A. nigricornis* Meig., *Trypeta fratria* Lw. and *T. Heraclei* Linn., *Ortalis rufipes* Lœw and *O. marmorea* Fab., *Drosophila* sp. indescr. and *D. funebris*, *Ephydra atrovirens* Lœw and *E. micans* Hal. and many other species.

group may be formed of the likewise very númerous species which, although so like some European species as to be at first glance mistaken for them, show upon nearer examination very definite plastic characters. The discovery of these characters often requires a great deal of attention; nevertheless they are of such a nature that the comparison of even single specimens leaves no doubt as to their specific differences.[6]

The large number of species contained in all the four groups shows that the Dipterous fauna of North America is not only very much like the European fauna, but that there is between them a relationship of a more intimate kind, which is to be compared only with that uninterrupted succession offered by the Dipterous fauna of the whole northern part of the Old World. There are no other two countries on the whole globe, so far removed from each other and showing at the same time anything approaching this relationship in the Dipterous faunas; generally other countries have but a small number of such species in common, which occur in both in absolutely identical specimens or only slightly different in coloring; otherwise their faunas have no points of contact whatever.

In order to form a more definite opinion on the origin and the nature of this close connection between the Dipterous faunas of Europe and America, it is necessary to elucidate somewhat more in detail the facts relating to this connection.

The laws regulating the distribution of the Diptera are somewhat different from those of the other orders of insects; and this difference is due to the considerable power of flight which many Diptera possess, and to the simplicity of the conditions under which they can live and their brood can prosper. As the *Libellulidæ* show in this respect the nearest approach to them, the laws of their geographical distribution may also be the nearest to those of the Diptera. The latter laws differ from those of the other orders of insects, by the wide area of distribution of the single species and by the configuration of these areas. They are not nearly the same for the species of all families, but vary according to families, so that the *climatic character* is most clearly expressed in those which have the smallest area, as for instance in the family of *Asilidæ* and some others. Although it can be admitted, as a general rule, that the extent of the area of distribution is in direct proportion to the power of flight and the sim-

[6] As instances of such species may be named: *Chrysopila quadrata* Say and *Chrysopila nubecula* Fall. *Leptis vertebrata* Say, and *Leptis annulata* Deg., *Leptis scapularis* Lœw and *Leptis lineola* Fab., *Atherix vidua* Walk. and *Atherix immaculata* Fab., *Arthropeas americana* Lœw and *Arthropeas sibirica* Lœw, *Chrysotoxum pubescens* Lœw and *Chrysotoxum octomaculatum* Curt., *Volucella evecta* Walk. and *Volucella bombylans* Linn., *Helomyza assimilis* Lœw and *Helomyza Nemorum* Meig., *Helomyza lateritia* Lœw and *Helomyza flava* Meig., *Sepedon pusillus* Lœw. and *Sepedon spinipes* Scop., *Philygria opposita* Lœw and *Philygria punctato-nervosa* Fall.

plicity of the conditions required for the existence of a species, still some families show in this respect peculiarities which do not find a satisfactory explanation in those two causes.

On account of the very great extent of the area of distribution of the Diptera in general, the faunæ of distant countries have many more species of this order in common, than of any other order of insects. The same causes on which this extent of distribution depends facilitate even in our days the importation of Diptera much more than that of other insects, through the intercourse between countries. It is well known that *Musca domestica* has followed the European settler everywhere. Wherever man penetrating into distant countries has carried provisions of smoked meat and cheese along with him, *Piophila Petasionis* and *Casei* have accompanied him. They occur in Greenland, as well as on the Gallopagos Islands, in the land of the Egyptian Fellahs as much as in the backwoods of North America. Where horse and sheep have become acclimated, *Gastrus Equi* and *Cephalomyia Ovis* have settled with them. *Bombylius punctatus* and *Toxophora maculata*, the powers of flight of which acquire, with the increase of heat, very great energy, are found everywhere between Southern Europe and the Cape, and the beautiful *Symmictus costatus* is found together with them, from Spain to the southern extremity of Africa. The barrier of a sea is not sufficient to stop the progress of the unwieldy *Olfersia Ardeæ*, as it has the heron for conveyance, and *Anaptera pallida*, although unable to fly, occurs wherever the swallow builds its nest. The simple conditions required for the existence and the reproduction of *Medeterus inæqualipes*, common on the shores of Sweden, allowed this species to spread all over the coasts of Europe and of Africa, as far as the Whale Bay. The species living on cultivated plants have acquired a wide area with them, as for instance several of *Oscinis* and *Chlorops* with the cereals, also the noxious *Cecidomyia destructor*. *Petalophora capitata* occurs wherever the orange and the lemon are cultivated and with the extension of the culture of the olive-tree, *Dacus Oleæ* has followed it.

It would be easy to multiply instances of this kind. Those above given are however sufficient to show that immense distances and wide seas are no insuperable obstacles for the spreading of Diptera, and that a lively shipping intercourse between two countries may easily carry over species from one fauna into another, and, the circumstances being favorable, even permanently colonize them. It is no wonder therefore that America, which for a considerable period of time has been in constant and always increasing intercourse with Europe, should have with the latter so many species in common. It would be more wonderful if this had not taken place. But a different question is,

whether the existing intercourse between the two continents is sufficient to account for the large number of species common to both. I am satisfied that it has to be answered negatively.

In order to investigate the influence of a prolonged intercourse of this kind between two countries separated by a sea, I have repeatedly directed my attention to the comparison of the Dipterous faunas in the countries surrounding the Mediterranean. These investigations, for which I possess abundant materials, have made me, as far as it was possible, thoroughly acquainted with the influence exercised by an intercourse of this kind on the intermingling of the faunas, and have afforded me a measure of this influence. In drawing a conclusion from the extent of these influences in the countries adjacent to the Mediterranean, to the extent of the same influences as existing in consequence of the intercourse between Europe and America, we have to take into account the comparatively recent epoch when this latter intercourse began, the much greater distance between the two continents, and before all, the much greater length of time required for a passage between them, especially in former years. In view of all these causes, tending to diminish the probable influence of the intercourse on the intermingling of the faunas, we cannot possibly admit that the occurrence of such a large number of species, common to both sides of the ocean, should be merely the result of an intermingling brought about by this intercourse. It should be borne in mind that it is not with one or two dozens of species that we have to deal, but with a number already reaching the second hundred, and that such species, found on both continents, far from being, in either of them, rare guests of sporadic occurrence, are equally common in both, so as to necessitate a serious revision of the synonymy of the described European and North American species. I will readily admit that *Musca domestica*, *Cyrtoneura Hortorum*, *C. meditabunda* and *C. stabulans*, as well as *Pollenia rudis*, have been imported from Europe to America; it can hardly be doubted that *Scenopinus fenestralis* and *S. lævifrons* can easily be brought over in ships; the conformity of many species of *Scatophaga* and of *Barborus* can be explained in the same way; the reason of the occurrence of a number of the same species of *Drosophila*, in both countries, is easily found in their mode of life; nor will it appear very extraordinary that *Drosophila ampelophila*, discovered by me in immense numbers in the raisin-stores of Smyrna, should be a common insect in Cuba; it is also a fact, that the North American *Maliota posticata* has been several times caught in Europe and described as a European species, under the name of *M. cimbiciformis*; that *Eristalis æneus*, not rare in North America, should be a descendant of European parents, is easily possible, as a ship affords the necessary conditions for the preservation of the larves. It

will be more difficult, however, to explain how *Ilythea spilota*, *Dichæta caudata* and *D. brevicauda*, *Ochthera Mantis*, etc., should have crossed the sea. The importation of some species, as, for instance, of the beautiful *Psilopus albinotatus*, discovered by me in Rhodus, seems almost inexplicable, and still this species is perfectly identical with the North American *P. pallens*. That all the species, now occurring on both continents, should have been gradually carried over from one to the other is utterly improbable. If we admitted this supposition, then, considering the large increase of the intercourse within more recent time, and the shortness of the passages now attained, we should also admit that most cases of importation have taken place, if not within the last ten or twenty years, at least during the last half a century, and secondly, we would have to infer that this importation of species was a reciprocal one. But if the latter was the case, the study of the European Diptera would have long ago detected the existence of these large importations from America; the Dipterous fauna of England especially, owing to the most frequent intercourse of this country with America, would have shown evident traces of such exchanges of species; in our sea-ports likewise, the appearance of single species of recent importation would have been noticed and their spreading from these centres, observed. Although I readily admit that the knowledge of the European Diptera is still very imperfect, nevertheless occurrences of this kind, owing to the large number of cases, would not have escaped attention. We have to conclude then, for the present, that the importation of species through the agency of frequent intercourse, does not afford a sufficient explanation of the large number of species common to Europe and North America.

As to those North American species, which are distinguished from European ones merely by a difference in the coloring, the question arises, whether they can be considered as descending from the same stock. It is an undoubted fact that species with a wide area of distribution show, in very remote parts of this area, a perceptible difference in coloring, sometimes even a very decided aberration in the picture. Such is, for instance, the case with *Anthrax bifasciata*, which shows toward the east a much more pronounced contrast between the white and the black coloring of the body, and acquires besides some slight, but very definite, peculiarities in the picture of the wings, so that an eastern specimen can be immediately recognized among a number of German ones.—Still better known is the influence which certain regions exercise on the coloring of all the species occurring there; this is, for instance, in a very striking degree, the case with Iceland. A collection from that country, at a cursory view, seems to contain many new species, but upon closer examination, these spe-

cies prove to be merely varieties of well known European species; they owe their existence to the propensity of all colors to merge into black and to the greater extent and intensity of the black itself, so that a light-colored picture upon black ground becomes much narrower or even disappears altogether. It can be likewise shown, that more confined localities exercise a similar, although less pronounced, influence on the coloring of the species. Under these circumstances, the question whether the North American species, above alluded to, are of the same descent with the corresponding European species, must be answered by an affirmation.

The same question may be proposed about those North American species which deviate from European species only by slight plastic differences, often merely a small variation in the size of some organ, or in the length and density of the hairs and bristles. Similar modifications are sometimes observed among specimens of European species. Thus the specimens of *Gymnopternus Sahlbergii*, caught in the southern parts of Switzerland differ so much from the Swedish specimens by the hairs and bristles on the first joint of the middle tarsi of the male, that they might be taken for different species, if all the intermediate forms did not occur in the countries lying between those two extremes. Still more striking is the difference between the male specimens of *Empis maculata* Fab., (not the *Empis variegata* confounded with it by Meigen,) caught in southern Germany and Sicilian specimens, the latter having on the fore tarsi hairs of unusual length and stoutness; the specimens from Lombardy are still a good deal like those from southern Germany; in those from Florence the hairs on the fore tarsi are already quite conspicuous, and they are still longer in the specimens from Rome, so that in this case the specific identity is proved by a gradual transition. Under such circumstances, the question, whether species showing but slight differences of the indicated kind should be considered as derived from the same stock, cannot be answered negatively. I readily acknowledge that it is rather difficult to state modifications of what parts in the Diptera have to be considered as essential and which as unessential, as different rules prevail in this respect in every family, in many families even in every genus, rules which a special research alone can determine. The only tolerably reliable general law prevailing in this case is, that all modifications in the structure of the mouth or of the genital organs are of the highest importance, whilst, on the contrary, all the other differences, observable even in the two sexes of the same species, are the least important.

We have now reached the category of those North American species which show a great resemblance to European species, but possess at the same time very definite plastic distinctive

characters; for brevity's sake I will call them *analogous* species. If we put now the question, whether it is to be assumed, that such analogous species may possibly have a genetic connection, we will find that all observations hitherto made on living Diptera warrant a negative answer. There is not a single instance on record which would justify the conclusion that under the now prevailing natural conditions, any species could be modified in that way, either through climatic influences, or in consequence of a compulsory change of food or through the contact with some other species. I do not deny that every time I compare such analogous species, the question forces itself upon my mind whether that, which seems impossible now, was not possible at some former period, as the impression left by such a comparison is most decidedly that of a common origin.

The European and the American Dipterous faunæ always appear to me like two branches of the same stock, each having had a development of its own, very similar however to the development of the other. But if there really was such a common stock for both, it is to be sought among the Diptera of a former geological period, and if the European and the North American Dipterous faunæ are to be considered as branches of this stock, the necessary inference would be that at a former period Europe and America had a continental connection.

Are the amber Diptera preserved fragments of this common stock?—Did a continental connection between Europe and America really exist at the time when they lived?—Did the submersion of an Atlantis tear asunder the branches of this stock? Was this catastrophe accompanied by changes which modified the general laws of development of the common stock in such a manner as to produce a difference between the further development of the stronger American branch and of the weaker European one, a difference not excluding at the same time a great deal of analogy?

Allow me to conclude my discourse with these unanswered questions. All those problems to which the study of the living and fossil Diptera affords a solution, or at least seems to afford one, I have done my best to answer. In doing this, I purposely remained within the exclusive limits of Dipterology, partly owing to my conviction that the interest of truth is best promoted when one confines himself to the investigation and discussion of a question from the point of view of his own speciality, partly because condemned as I am to a total literary isolation and absorbed now for years with utterly unscientific occupations, I am but very imperfectly acquainted with the researches made in a similar direction, especially with those of later years.

ART. XXVIII.—*Abstract of Prof. Meissner's Researches on Oxygen, Ozone, and Antozone*;[1] by S. W. JOHNSON.

DR. MEISSNER has submitted the ozone and antozone question to an extended and masterly investigation; at least such is our impression from a careful perusal of his treatise, an octavo volume of 370 pages, the preface of which bears the date of Feb., 1863. This book is appropriately dedicated to SCHÖNBEIN, whose name will stand in imperishable connection with the remarkable discovery of the triple nature of oxygen—a discovery which must, ere long, give us a new insight into the relations of matter to force, and modify, in a radical manner, some of the doctrines now current in science.

In the preface it is distinctly announced of ozone and antozone that one of them can not be formed without the other simultaneously appearing. This is a discovery of the utmost importance, and we shall endeavor to present briefly the author's arguments in proof of its reality.

In the *Introduction* is presented a concise but comprehensive sketch of the history of the ozone question up to date of publication. Section I. bears the heading: THE RELATIONS OF ELECTRICITY TO OXYGEN, and is divided into two chapters, of which the 1st, of 200 pages, relates to *Electrized Oxygen*, and the 2d to *Ozone and Antozone.* These headings are made appropriate by the history and progress of the investigation rather than by its results. The second section, of 72 pages, is entitled: THE POLARIZATION OF OXYGEN IN THE ACT OF COMBUSTION; and the concluding section, of 84 pages, OZONE AND ANTOZONE IN THE ATMOSPHERE. In section I, Meissner states that the object of the first part of his investigation is to ascertain whether, as all previous experiments would appear to show, the effect of electricity on oxygen is simply to convert it, or a part of it, into ozone, or whether, as Schönbein in 1861 had assumed from theoretical grounds, the ordinary inactive oxygen is polarized into the two opposite oxygens, the negative-active ozone and the positive-active antozone.

To electrize oxygen the apparatus of von Babo (*Verhandl. der Naturforsch. Gesellschaft zu Freiburg*, ii, p. 331), imitated from an instrument of W. Siemens (*Pogg. Ann.*, 1857, B. xii, p. 66, p. 120) was employed, in which ozonization takes place in a thin stratum of air, and is determined by the silent discharge from poor conductors. This apparatus is made as follows: twelve very fine copper wires, such as are used in covering violin strings, and about five decimetres long, are inserted each into a very

[1] *Untersuchungen über den Sauerstoff von* Dr. G. MEISSNER, Professor in Göttingen. Mit einer Lithographirten Tafel. Hannover, 1863.

thin glass tube somewhat longer than itself and about 0·3 mm. in width. Each of these tubes is sealed at one end. Into the other end is fused a wire of platinum which, within the tube, is twisted with the copper wire, and without the tube projects an inch or so. The twelve tubes thus made, are arranged within a glass tube 7 mm. wide and 6 decimetres long, so that the projecting platinum wires of six of them are at one end and those of the other six are at the other end of this wide tube. These two sets of wires are each twisted about a larger platinum wire which passes through and is fused into the wall of the wide tube. The tubes of the one bundle are distributed among those of the other as equally as may be; they are, moreover, in close contact, and the spaces surrounding them are as narrow as possible. On connecting the extremes of these two series of inclosed wires with the electrodes of the secondary coil of a powerful induction apparatus, the electrical discharge takes place through the walls of the narrow tubes and through the air that surrounds them. The discharge is unattended with sparks, and on approaching the ear only a faint crackling sound is perceptible. In the dark the bundle of fine tubes shines throughout its whole length with a reddish-violet light. During the electrical action the air bathing the small tubes is powerfully ozonized. By adapting suitable apparatus to the large tube the ozonized air may be removed and submitted to examination, and its place supplied with fresh air, at pleasure. In Meissner's resarches the air of this ozoniser was renewed by the pressure of a gasometer. It was found necessary that the air should be perfectly dried before being subjected to electrization. In endeavoring to effect this object the author had no little difficulty. He finally accomplished it by the use, first, of a wide tube, more than a meter long, filled with chlorid of calcium, and secondly, of two or three wide tubes, 1–1½ metres long, filled with coarse glass beads drenched in oil of vitriol.

The perfectly dry air, after traversing the ozonizer, was submitted to the action of reagents in receivers of glass connected with the ozonizer by means of a mercury joint, this metal being unaffected by dry ozone.

The first point Meissner sought to investigate was whether dry electrized air, after being deprived of ozone, possessed properties other than those of common oxygen and nitrogen. He found that by transmitting it through a strong solution of iodid of potassium it was readily and totally deprived of ozone; the stream of air thus deozonized exhibited nothing remarkable until it had been passed through pure water, but, as it emerged from the water, it appeared in the form of a thick white *mist*, perfectly similar to that formed by the cooling of steam, which was sometimes so dense as to render the part of the small vessel

filled with it quite opake. There was no perceptible change of temperature, and the mist was formed equally well whether the water traversed by the deozonized air indicated 35° or 0° C. The mist also appeared when the stream of air merely passed through a moistened tube, and sometimes the cloud formed at once, when the air escaped from a somewhat dilute solution of iodid of potassium; but in case this solution was concentrated, and especially when the air on leaving it streamed through a chlorid of calcium tube, no mist appeared until the air came in contact with water.

The appearance of the mist strictly depends upon the action of the induction instrument. When it ceases to work, the mist disappears, allowance being made for the time occupied by the air-current in traversing the apparatus. The mist is denser or rarer the more or less vigorous the electrical excitement. The same cloud is formed when other deozonizing agents are employed instead of iodid of potassium, viz: pyrogallic acid, and likewise, when, in the absence of a reducing solution, the dry electrized current comes at once in contact with water.

Further experiments demonstrated that the cloud is formed when *pure oxygen gas*, prepared either by electrolysis or from chlorate of potash, is submitted to the electric influence and subsequently treated as above described, while that under the same circumstances pure nitrogen and pure hydrogen suffer no apparent change.

The author found himself thus led to the conclusion that when oxygen is subject to electrical action there is formed *simultaneously with ozone another modification of oxygen* which he naturally sought to identify with Schönbein's antozone. In this however he failed at first, and hence adopted, and for a time employed, for this cloud-forming state of oxygen the name *atmizone* (ατμίζω, I smoke or fume). Finally, however, there was left no reasonable ground for doubting the essential identity of atmizone and antozone.

The cloud produced when ozonized air slowly bubbles through water is heavy, rests on the surface of the liquid, and when a vessel full of it is inclined it flows over the edge and falls like carbonic acid. By conducting it through a tube to the bottom of a dry glass cylinder, it displaces the air, preserving a sharply defined boundary, and by gentle agitation is easily broken into cloud-like masses.

When a large dry flask is nearly filled with the antozone mist, then well closed and left to itself, the mist gradually becomes thinner, less opake and less defined at its boundaries, and in 30 to 45 minutes vanishes altogether, leaving a clear atmosphere; while upon the walls of the flask water is deposited, at first to a slight extent, afterward accumulating in droplets which finally

flow together to the bottom of the vessel. This disappearance of the mist is entirely spontaneous, and independent of changes of temperature. It is impossible to reproduce the mist in the air out of which it has disappeared, by contact with more water. The water which precipitates from the cloud may be perfectly pure, though it is not so always. The air remaining has all the characters of the ordinary atmospheric mixture.

Antozone has thus the property of taking up water, conferring upon the latter the peculiar physical conditions of a cloud or mist, and after a short time depositing it again in droplets as it itself is transformed into ordinary oxygen.

By passing the antozone mist into desiccating substances, as chlorid of calcium, it is deprived of water, the antozone becoming transparent, but retaining its faculty of giving a cloud when brought again in contact with water. Many strong saline solutions likewise deprive antozone of water; hence the non-appearance of the cloud when the stream of electrized air emerges from a strong solution of iodid of potassium. It does appear however when the solution is sufficiently dilute.

By comparing the capacity for water, of a stream of ordinary air or oxygen with that of an electrized current of the same volume at the same temperature, Meissner found that the latter was nearly double the former, as measured by the increase in weight of a chlorid of calcium tube. This eminent hygroscopic capacity of antozone accounts for the difficulty of drying electrized air completely and explains how Baumert found hydrogen in his experiments when using an apparatus which was capable of drying common air perfectly.

In the dry state antozone likewise reverts to common oxygen as shown by a gradual decrease of power to form a cloud with water. This conversion goes on, however, more slowly than when it is moist, occupying 1 to 1½ hours for its completion.

Under the conditions in which antozone so quickly disappears, ozone is, on the contrary, very permanent, and although when a mixture of the two active oxygens is placed in contact with water (and glass) only, in a stoppered flask, some ozone is destroyed during the reversion of the antozone, the larger residual portion remains almost if not quite unaltered for months. The high temperature, 235° to 240° (Andrews), which at once destroys ozone has the same and an equally instantaneous effect upon antozone, whether the latter be dry or moist. Antozone, moist or dry, also reverts to common oxygen by contact with platinum-black, or with the binoxyds of manganese or lead.

The deportment of antozone as above described, is modified by the presence of ozone. When the current of electrized air or oxygen is divided into two equal parts by being forced from he main tube into two smaller divergent tubes, and one of these

branch currents is deozonized, the other passing on unaltered, it is found when they emerge from a vessel of water that the cloud formed by antozone is much denser in the deozonized current than in the other. Meissner's experiments lead to the conclusion that when antozone, ozone, and aqueous vapor are in contact, in the first place, the attraction of antozone for water is diminished by the ozone, and, in the second place, the presence of ozone causes a much more rapid destruction of antozone than happens otherwise.

Meissner deems it highly probable that antozone and ozone are produced in equivalent quantities in the electrized oxygen, though we as yet possess no experimental data on this subject. It is probable that in so far as ozone causes the destruction of antozone (moist), both revert to common oxygen in equivalent quantities. Since however ozone is much more permanent of itself than antozone, it is not to be expected that in a mixture the two will disappear to an equal degree.

As regards the behavior of a mixture of ozone and antozone in *absence of moisture*, the author makes the following observations. Antozone when mixed with ozone, both being dry, reverts to inactive oxygen much more slowly than happens either when the two exist together in the moist state or when dry antozone alone spontaneously undergoes this change. He also finds on the other hand, that when antozone does vanish from the dry mixture, it involves in its change more ozone than disappears from the rapidly altering moist mixture.

Meissner proceeds to an experimental comparison of his *Atmizone*, (which name we may use provisionally,) with Schönbein's *Antozone*. The first point was to ascertain if atmizone could oxydize HO to HO_2 as Schönbein found true of antozone.[1] In examining this question the author was led to repeat Schönbein's experiments on the production and reactions of HO_2. He confirmed the observations of the latter concerning the character of the gas evolved from a mixture of BaO_2 and HO, SO_3, and its capability of oxydizing HO to HO_2. The simplest mode of preparing a pure solution of HO_2 is to support a short, narrow tube containing pure HO, SO_3 within a larger tube or bottle an inch or so in width, furnished with a ground-glass stopper, and filled with water nearly to the top of the smaller tube. BaO_2 is now added in small quantities, at intervals, to the HO, SO_3, elevation of temperature being avoided as far as possible, and the bottle being closed after each addition. The oxygen evolved in this process mostly appears, however, in the ordinary inactive state, and the solution of HO_2 is therefore extremely dilute. Meissner found that to prepare a pure and concentrated solution

[1] In distinction from ozone.

of HO_2 it was only necessary to pass CO_2 into water, mixed with BaO_2, BaO, CO_2 and HO_2 resulting. In this way he obtained directly, a solution so concentrated that it decomposed under the influence of light.[1]

As a means of detecting HO_2, the author found Schönbein's reagent, viz: iodid of potassium and starch-paste in conjunction with protosulphate of iron, to possess the greatest delicacy and to be most characteristic when applied with certain precautions, especially when the ferrous salt is employed in very minute quantity. As regards the reactions that occur between this reagent and HO_2, Meissner after adducing the somewhat contradictory statements made at different times by Schönbein, is led to conclude that HO_2 is without effect on KI, in neutral solution, except in presence of some "predisposing" agent, like FeO, and that contrary to Schönbein's opinion the first action consists in an oxydation of FeO, to Fe_2O_3 and that the deoxydation of HO_2 thus begun, continues in presence of KI after all FeO has been oxydized and results in the oxydation of KI and destruction of HO_2. The presence of any acid suffices to induce the reaction between HO_2 and KI, instantaneously when the acid is added to a mixture of HO_2 and KI; but after a considerable interval, and in a much less marked manner, or even not at all as measured by the separation of I, when the HO_2 is mixed with an acid *previous* to the addition of KI. Our author's theory of the mode in which the well known power of acids to prevent decomposition of HO_2 on the one hand, and their decomposing effect on *pure* KI, as shown by Baumert and confirmed by himself, on the other, give this curious resultant, we leave to those specially interested in these subjects to study in the original. In continuing this necessary digression, Meissner gives the results of his observations on the fluor spar of Welsendorf. Like Schönbein, our author found that the reactions of water which had been ground with this fluor spar were different according as it had been for a shorter or longer time in contact with the mineral—but were undeniably those of HO_2, while the presence of antozone in the spar was equally certain. As to the condition in which it there exists, or how it may possibly be produced by grinding, Meissner feels unable to offer any hypothesis. He looked in vain for evidences of antozone in other minerals which manifest a peculiar odor when submitted to friction. Not even in a compact fluor from Ivikaet in Greenland, which has been mentioned as having properties similar to that of Welsendorf, could any be detected.

Oxydized oil of turpentine, Meissner found to give the same reactions as the Welsendorf fluor. He concludes that in both

[1] Debray and Balard had previously (?) published the same method, (*Comptes Rend.*, lv, 736-8).

antozone or the product of its action on water, viz: HO_2, is present, and that besides, there exists in both a substance which like ferrous sulphate "disposes" HO_2 to act upon KI, since they decompose KI without the addition of FeO, SO_3.

Returning to the question of the identity of atmizone and antozone, Meissner informs us that a liquid having the reactions of HO_2 is obtained when a current of electrized air is passed for some hours through a strong and alkaline solution of pyrogallic acid, (which deprives it completely of ozone), and subsequently through pure water. The water slowly acquires a recognizable content of HO_2 giving with KI and starch no reaction until the addition of FeO, SO_3, when an instantaneous liberation of I becomes manifest. Atmizone, however, appears capable of oxydizing water only when it is newly formed. If the stream of electrized and deozonized air is passed through a series of vessels containing water, HO_2 scarcely appears in the second and subsequent vessels, though the atmizone cloud is formed in them all. This cloud, however, is the less dense and well defined, the farther from the induction apparatus it is produced, and it may hence be inferred that atmizone loses its power of oxydizing HO when its electrical polarity has declined beyond a certain point. The water through which the deozonized current of air has been passed, contains nothing but HO_2: no traces of NH_3 or oxyds of nitrogen can be detected in it. Since, according to Schönbein, antozone is without effect on pyrogallic acid in alkaline solution, this experiment gives double proof of the identity of atmizone and antozone.

At this point in the investigation Meissner encountered a phenomenon of the most extraordinary character. He found that water through which was passed a current of electrized air deozonized by a solution of iodid of potassium, contained a substance which liberated I from KI on addition of an acid, even when the air after leaving the alkaline deozonizing solution was carried through a concentrated potash solution contained in a Liebig's bulb tube! The liquid could not contain NH_4O, NO_3 nor HO_2, for on evaporation to dryness at 100° C., there remained a very minute residue which when redissolved in pure water had all the properties of the original liquid; while, as is well known, NH_4O, NO_3 and HO_2 are completely decomposed and dissipated by this treatment.

No substance having the properties in question could be imagined present save iodic acid which is known to liberate I from KI and which is likewise formed when ozone acts upon KI. But in what manner this body could pass out of one alkaline solution and through another, as must be the case here, was difficult to conceive. Meissner at once attempted to demonstrate directly its presence or absence. He therefore put his electrizing

apparatus into prolonged action, (six hours daily for eight days,) passing the stream of electrized air first, through strong solution of KI, then through concentrated potash lye, and lastly through three vessels of water. When this experiment was finished, the water of the receivers reacted very powerfully on KI. It was concentrated by evaporation, in which process it finally acquired an acid reaction, first reddening and afterward bleaching litmus paper. A crystalline residue remained which when dissolved in water and treated with SO_2 gave a copious separation of iodine. Other reactions confirmed this substance as IO_5. On further experiment it was found that so soon as the atmizone current was deprived of its *moisture* it was no longer capable of transporting IO_5. It would therefore appear that when iodine is set free in the solution of KI by the action of the ozone occupying the periphery of the air bubble, a portion of it, vaporizing inwardly, is there oxydized by ozone to IO_5 and then is taken up by the atmizone cloud, and by it transmitted through the various solutions.

In the next place Meissner examined the deportment of Schönbein's antozone to water vapor, to ascertain whether it possessed the cloud-forming property. By experiments with the gas evolved from BaO_2 and HO, SO_3, this was found to be the case, and the antozone cloud resembled, in all particulars, that yielded by atmizone. If, for example, a tube containing the just mixed materials for giving off antozone is carried into a flask occupied with moist air, the latter gradually becomes filled with a cloud which disappears again after a short interval.

Another point to investigate was the deportment of antozone toward solution of KI. Schönbein asserted that antozone decomposes this salt and oxydizes its elements, while atmizone appears to be unaffected by it. On repeating Schönbein's experiment, and further investigating the subject, Meissner concluded that the reaction observed by Schönbein was due to the sulphuric acid of the mixture being mechanically projected against the test papers. At least, when solution of KI was placed in a vessel beside the tube evolving antozone, no iodine was liberated in the former until after the addition of FeO, SO_3. Schönbein himself has lately expressed the probability that antozone does not decompose KI.

In one further particular, there is a difference between atmizone and antozone which Meissner was unable to account for satisfactorily. Antozone has a peculiar odor, and when breathed excites a choking sensation, while atmizone manifests neither of these properties. It is possible that antozone, as evolved from BaO_2 and HO, SO_3, may be accompanied by some other substances to which this odor, &c. is due. The close correspondence in all other respects must warrant the conclusion that the two are essentially identical.

The author now goes on to give the results of his observations on the deportment of the mixture of ozone and antozone as obtained by the electrization of pure oxygen. He finds that ozone does not prevent the union of HO with antozone, with production of HO_2. When instead of pure oxygen, common air is electrized the nitrogen of the latter becomes involved in the reactions, and in water through which the electrized mixture is passed, nitric acid gradually accumulates, but chiefly in the *first* water-receiver. When the electrized air has become charged with moisture, the production of NO_5, (as well as that of HO_2 which is simultaneously formed,) is lessened to an extraordinary degree.

Schönbein's statements regarding the generation of NH_4O, NO_3 made it necessary to look for this salt in the electrized air. Meissner affirms that NO_3 cannot be safely distinguished from HO_2 by means of KI and starch, for no decided difference in the amount of iodid separated by addition of an acid or of FeO, SO_3 can be perceived. Nitrous acid must therefore be detected in some other manner when, as in the case before us, it is mixed with HO_2. When nitrates are treated with *dilute sulphuric acid*, NO_3 is liberated and by contact with FeO, SO_3, is reduced with manifestation of the reaction for NO_2 (the brown coloration). The water through which electrized air had been passed, was evaporated, after addition of KO, to a small bulk, strong solution of ferrous sulphate was added to the cooled liquid, and lastly dilute sulphuric acid, but in no case was any reaction observed. Only on employing *concentrated sulphuric acid* did the brown coloration appear. This experiment Meissner rightly believes to demonstrate the presence of NO_5 and the absence of NO_3. In fact we should not expect to find NO_3 under these circumstances, as the excess of ozone would oxydize any that might at first appear. Ammonia could not be detected by Nessler's extraordinarily delicate test.

On passing electrized oxygen first through a receiver of water and then, in a second receiver, bringing it in contact with nitrogen (common air), it resulted that no NO_5 could be detected in the water of the first vessel, while in that of the second, it was readily found though in smaller quantity than in the previous experiments. It was thus demonstrated that the oxydation of N is not, or is not alone, a direct result of electrical action, but is the effect of the excited oxygen.

Further experiments, Meissner informs us, have demonstrated that neither ozone alone, (as Schönbein also has ascertained,) nor antozone alone, after deozonization by contact with KI and HO, can oxydize nitrogen to NO_5. Neither has antozone the power possessed by ozone of oxydizing the lower oxyds of nitrogen to NO_5.

In what precise manner ozone and antozone coöperate to oxydize N, Meissner does not claim to have fully decided. He is disposed, however, to think that antozone alone is capable of converting N to one of the lower oxyds, probably NO_2, and that this unites to ozone forming NO_4, which is really the first product that appears of the conjoined action of ozone and antozone on nitrogen. (In presence of 2HO, $2NO_4$ falls into HO, NO_3 and HO, NO_5, and HO, NO_3 is oxydized by ozone to HO, NO_5: this last named substance being thus the final product of the reactions in presence of water and excess of ozone.)

The influence of moisture upon the oxydation of N is next investigated. Schönbein in his late paper upon the formation of NO_4 from ordinary oxygen and nitrogen by electricity, (*Baseler Verhandlungen*, III, 2, p. 209,) has asserted that the spark of a powerful inductive apparatus produces NO_4 in a *dry* mixture of N and O, while in presence of moisture NO_3 and NO_5 appear. Meissner obtained this result by repeating the experiment with common air, using platinum electrodes. When the air was employed in its ordinary state, i. e. neither purposely moistened nor artificially dried, NO_4 was copiously produced; by addition of HO, NO_3 and NO_5 were formed. Meissner could obtain in this experiment no direct evidence of the formation of ozone or antozone. Since, however, the numerous trials of De La Rive, Fremy, Becquerel, Marchand and others, have abundantly demonstrated that ozone is produced when the electric spark is discharged through pure oxygen, it is obvious that in Schönbein's experiment the ozone was formed, but at once consumed in oxydizing nitrogen. Since ozone alone cannot oxydize nitrogen, but requires the presence of antozone, Meissner sought for this substance and readily found it in the pure oxygen, electrized by spark-discharges. In air electrized by the spark, antozone is also to be found, provided ozone be at once absorbed by a moist crystal of KI or a strong solution of the same placed in the close vicinity of the electrodes. Under these conditions the antozone cloud is copiously produced. When ozone is not thus at once absorbed from moist electrized air, both it and antozone speedily disappear being consumed in the oxydation of nitrogen. When air which has been *perfectly dried* is electrized by sparks ozone and antozone appear but no NO_4.

The presence of HO is then essential to the oxydation of N, a fact which harmonizes with the statements first made by Fremy and Becquerel, viz: that the metals, &c. are oxydized by ozone only in presence of moisture.

The same electrical current gives by silent discharge through air of a given content of moisture, much less NO_4 and much more active oxygen than when it passes in sparks. The appearance of NO_4 in case of electrization by sparks is due to the heat

produced in this process, for by heating a current of air electrized by the silent discharge, in such a way that it comes immediately in contact with water, ozone and antozone at once disappear, and NO_4 is copiously formed.

In further experiments, the author demonstrated the presence of HO_2 in water, near whose surface electrical sparks had been made to play.

Thus far we have given quite fully the facts observed by Meissner in the first chapter of his book. He finishes the experimental part of this chapter with an account of observations which lead to the conclusion that the production of ozone and antozone is the result of electrical *tension*, and occupies about 40 pages in a discussion of the theories of Clausius, Schönbein, De La Rive, and Brodie, and in unfolding his own theoretical views. To render his ideas intelligible would occupy more space than we have at command. In fact, this part of the volume scarcely admits of abstract. All who are interested in these topics will not fail to study thè original.

(To be continued.)

ART. XXIX.—*Glacial Action about Penobscot Bay*; by Mr. JOHN DE LASKI.

PREVIOUS to the year 1859, the writer, like most ordinary readers who are familiar with the descriptions of the phenomena of boulder action given in our text books, believed that the drift material of clay, sand, gravel, boulders, and the scoring of the rocky surface of the country, must have been the effects of iceberg action. Up to that time I had not seen any mention whatever of the former existence of glaciers in any part of Maine; and I was therefore quite unprepared to doubt that the numerous examples of the striated surfaces about the village where I resided —Carver's Harbor, Vinalhaven—were other than those made by the chafing of floating ice-mountains over the ledges when these formed the bottom of a continental sea. The theory of Hugh Miller in his "Popular Geology," a work then recently published, had attracted my attention, which supposes that the eastern deflection of the Gulf stream, at the close of the Tertiary era, carried the northern icebergs over Great Britain at the time when it was undergoing the process of submergence, and that the bergs were able to mount the submarine hills and score and scratch them regularly, as the country went slowly beneath the surface.

But on attentively examining the scratched rocks of the vicinity of Penobscot Bay, I could not reconcile the iceberg doctrine with the facts connected with these scratches and with the exten-

sive denudation of the country everywhere presenting itself to the eye. It is quite evident that the formations of Penobscot Bay had not been materially disturbed for a time indefinitely long preceding the Post-tertiary age; for the syenite lies in layers, generally horizontal, of varying thickness, from a few inches to twenty feet and sometimes more; and the slates of the coast have but one usual dip and strike. The irregular denudation of the granitic floor of the region of the Penobscot Bay was certainly posterior to the Tertiary times; and icebergs, if we adopt the theory, ought to have left the country vastly more level, where the granite abounds, than it actually is.

The hills of the coast generally rise abruptly from the valleys and the sea. They are scored alike along their eastern and western flanks, and in similar style of execution, whether the angle of slope is great or small. I could not discover any difference in the appearance of the striæ upon the tops of the hills, their northern, eastern and western sides, or at their southern bases, except that around the southeastern and southwestern foot of the hills the scratches were occasionally gently curved. I sought everywhere among those hills and ledges for those *breakages* in the lines of the scratches, which the passages of icebergs over an undulating sea-bottom would produce, but found none. On the other hand, there were examples of denuded and scratched rocks on the southern sides of hills remarkable beyond description. The ice in some of our northern rapid rivers about the beginning of the year is sometimes pressed up until the surface becomes exceedingly irregular. Now if a small patch of such a field could be partially leveled off, preserving, however, much irregularity of ridges, depressions and steep sides, all the while faithfully showing that art had performed the work, it might not inaptly represent some of those ledges of the granite formations of Penobscot Bay. They are smoothed and scratched in all manner of inequality. The agent that performed the task was an accomplished worker, and marched along over the surfaces of the rocks with great regularity, touching the surface beneath it with the same delicacy of action as the sides and top of the lofty eminence. There are nowhere to be seen the effects of rude and unsystematic blows upon the faces of any of the rocks; but everywhere method and regularity are exhibited, almost as if the worker had been directed by intelligence. There is a ledge of this character near my residence. It dips quite steeply toward the west. It can be seen that much of the rock was removed by piece-meal—chipped away as the "hewer of wood" might chip his fallen tree, or spar; and it is apparent that afterwards it became scratched by some means—sand and gravel attached to the under surface of a glacier, I believe—which accommodate itself to every inequality of surface, scoring down smoothly and evenly the face of the rock.

It is quite evident that these chips, some of which must have been many feet in length and breadth, were not removed by a blow, such as an iceberg has been supposed by some writers to make upon the rocky sea-bottom over which it is floating. Again I think it evident that the *blow* was not given horizontally, but rather at a very considerable angle,—say from 40 to 50°—and directed from the north; and that the breaking of the rocky floor was effected by *pressure*. These irregular depressions are generally upon protuberant ledges, the "embossed" rocks of the islands.

When such depressions are made upon the granitic floor of the country, the furrows are at right angles to the lines of the striæ. They are exceedingly common, and very uniform in structure. I have never seen a remark upon them by any one; and it seems to me that their peculiar shape is convincing evidence that neither icebergs nor diluvial waves had any share in their production. They are lunate in figure, having their horns pointing to the northeast and northwest, and their steep walls invariably looking towards the north, never directed *south* as stated in the "*Reports on the Scientific Survey*" for 1862, p. 383—an error not in the manuscript.

There is a corresponding phenomenon in shallow troughs, whose largest diameters are north and south; and here the horns are shorter, and directed more toward the zenith. Again, these furrows occur on rounded semi-cylindrical ledges, running north and south. When made on the tops or sides of such rocks, the mural face of the furrow still looks toward the north, but the horns point in the opposite direction, or toward the south. These lunoid furrows often exhibit, like the other depressions alluded to, the most delicate parallel striæ running over them from north to south. It seems evident that, had these minute striæ been made by the chafing of an iceberg over the ledge when a sea bottom, it would have broken down the wall of the furrow turned toward its approach; whereas, the movement of a glacier, slow and regular, having sand, as well as gravel and boulders, frozen into its under surface, would not be liable to cause such a result, if the rock which was pressing upon the ledge, producing the furrow, had passed along beyond it toward the south.

These furrows are from an inch in length to many feet. About three miles from the village there is one of these furrows upon a ledge dipping at a small angle toward the south and west. It is thirty feet long, two broad at the middle, with a wall at this part six inches high looking north. Behind it in this direction, there is a high hill, only a few rods from the furrow, having its southern front broken down into irregular terraces. Still farther north for two miles, the land continues to rise to not less than

two hundred feet, and stretches in the east and west direction for more than three miles.

Wherever the formation is of syenite—and there are about seventy-five square miles of surface covered with this rock, in Vinalhaven—the hills are broken down on their southern brows into step-like descents. There is one hill of this character in the town from twenty-five to fifty feet high and two thousand broad, nearly wedge-shaped, with its apex turned toward the north. I found, wherever I examined them, that the striæ had commenced to form at the southern foot of these hills, in straight parallel lines, generally very close up to the wall; and, in one case, a high granitic bluff of twenty-five feet overhung and *shaded* the striæ. They had begun their course at about a foot from the base of this wall. This high bluff continued for some distance toward the west, where again, the glacier—not icebergs—had under-worn it, in a strike north and south, with a steep roof-like dip toward the east. Along the entire width of this roof-wall the striæ were displayed in the most beautiful manner. The granite was of a coarse texture, and the wall was only reached by the waves of the highest tides; yet nowhere can be seen a finer polishing and scratching than is exhibited on this wall.

The hills all slope toward the north at an easy curve, and are steep on their southern sides; and the ledges all over the island, wherever the rock is hard and brittle, maintain the same aspect—being in irregular, parallel ridges, like broken windrows of hay in a farmer's field, down which a very strong wind is passing. These ridges represent the hills in miniature.

One example among the abrupt southern faces of those hills was of special interest. At the southern part of North Haven, (the island next above Vinalhaven, from which it is separated by a ship channel five miles long,) there is a hill, at the village, rising a little more than one hundred feet directly from the water. The formation here is trap. This hill may extend, east and west, six or seven hundred feet. All along its southern side the scratches radiate outward in straight parallel lines. At the western termination of this hill, the scratches are again in perfect development on the level ledges where the tide covers them at high water; and as we approach the hill, the wall rises perpendicularly from the shore and the scratches are continued upon its face. Even in crevices which are overhung by portions of the wall, the scratches are distinct and regular—as in the case, before mentioned, upon the sloping wall of granite. These striæ were throughout so fresh and well displayed, that it seemed as if an artist had been recently there at work with an instrument whose teeth were well guaged to follow regularly the planing chisel which had before smoothed the surface.

Half a mile farther east, where a continuation of this eleva-

tion slopes downward to the water, there stand alone several abrupt prominences, which resemble the elevated embossed rocks of some granitic regions. One of these is seven or eight feet above the tide flats. It has very steep walls on the east, southeast, west, southwest, and south. It dips gradually toward the north, and is connected with the bank by a covering of marine clay. The top and all its walls, excepting the south one, are well scored. Beyond, to the northeast, for half a mile, this elevation of a hundred feet terminates somewhat abruptly over a cove; but beyond this cove, to the north, there is a high ridge of a hundred feet, which is continued on toward the east, retaining this height for more than two miles, in a line nearly northeast from the embossed scratched rocks. It is evident that an iceberg could not have been driven here along the southern foot of these elevations, and afterwards set itself to work like a patient sculptor, leisurely and effectually chipping and molding the rock to the specific form of the hills and the ledges of the country. There are no scratchings on the rocks of the Penobscot Bay that indicate any such oscillation of icebergs from one general course of movement; neither do I believe that there can be found in this great fiord of the coast any curving of the striæ, or any variation of them from a general direction, which cannot be referred to the movements of a glacier.

About the same time, I discovered in the northern part of Vinalhaven an example of scoring and scratching of the bed rock, of a character altogether different from anything I had met with elsewhere. On the eastern side of a level ledge of granite of considerable extent, there is a fissure running north and south for about twenty feet. This fissure opens into the rock horizontally to the depth of six to eight inches, forming a shelf about six inches in thickness. The upper surface of the ledge had evidently been scratched, judging from the appearance, although the fine striæ had disappeared, the rock being the coarser kind of syenite which has very much disintegrated where not covered by soil. The lips of this aperture were smoothed, as if the opening had been made by a gigantic gouge and afterward rubbed down in one direction, for I found in passing my hand along toward the south that it was sensibly rougher than when touched in the opposite direction. On introducing my fingers into this horizontal fissure, and touching its upper surface—its *ceiling*—I was astonished to find that it was thoroughly polished and scratched also. Here there seemed to me to be decisive proof as to the origin of all these various phenomena. I saw that the iceberg theory could no longer be sustained; and that no other action but that of a glacier was competent to explain the facts.

Over the entire extent of the syenitic formation, boulders of

the same rock are strewn with wonderful profusion, and numbers of them weigh many tons; they rest on beds of soil several feet in depth, just as a glacier might have left them as it slowly melted away.

Upon the northern slopes of the hills the rocks are torn asunder in such a manner as wholly to preclude the idea that the work had been done by icebergs. Had bergs halted in such places, and through a long age, chafed against the northern walls of such high hills, the denudation, after all, would have been an insignificant affair; and none but the largest bergs could have worn at all the faces of the hills. But the debris of the stoss side of the hills has been transported *over* the hills, rather than along their sides; and we frequently find large boulders, evidently not far removed from their native beds, resting on the hills, and often in such a manner that their transportation and deposition could not have been accomplished through the agency of icebergs or oceanic waves.

As I have already remarked, the hills of the coast have a uniform feature: they are steep on the south, and have a gradual descent from their summits toward the north. I know of no exceptions to this rule. There must be a meaning in this specific form of the hills. If the ledges and minor hills of the islands of the great fiord of the State have been moulded into this peculiar figure by glacial action, or that of icebergs, I conclude that the denuding agent must have reached the tops of the Camden hills, 1400 feet high, and those of the island of Mount Desert, 2000 feet; for these maintain, when viewed from the east or west, the same general contour as the other hills of the coast. It is quite impossible that icebergs could ever have broken down the tops of those high hills. Moreover, if they had been under water to the depth of a thousand feet or five hundred, the sea which covered New England and the continent to the west would have had a warming influence on the climate, and would therefore probably have been quite clear of icebergs.

The sides of the Camden hills are scratched from their base to the summits. Megunticook, the highest but one, is broken down on its southern brow into a precipice of nearly 300 feet. Here, the striæ appear on a vein of colored quartz in a most beautiful manner. They are very delicate, and the rock is polished like glass. Toward the north, in the direction whence the scratching agent came, the hill continues to rise till it attains the height of one or two hundred feet above the brow. On descending the precipice by a circuitous route, and approaching its base, we are at once struck with the fact that this hill has been denuded or broken down from top to bottom. The perpendicular wall of Megunticook forms the northern side of a valley and the northern extremity of Mount Battie the southern side; into this

valley immense blocks of the gray micaceous sandstone from the brow of the overlooking hill have been projected—not as if they had merely tumbled down and accumulated as talus—for many of these boulders have been carried to a considerable distance over the top of the latter mountain, and are very perceptibly less angular than those which lie at the base of the precipice. Toward the southern extremity of Mount Battie, striæ appear again, one thousand feet above the sea; and the entire top of the mountain bears evidence that it has been thoroughly denuded upon a most magnificent scale. The boulders here found were not dropped from a passing iceberg which had been freighted in Labrador or beyond, but are of a peculiar rock, a quartzose conglomerate, unlike any other to be seen in this part of the country and identical in composition with the rock of the mountain itself. Not even three per cent of any other rock can be here found. The striæ continue down the southern brow of the hill to the plain below, though this part of Mount Battie is abrupt, falling off at an angle of seventy degrees or more. At this extremity of Mount Battie, along the ascent, the striæ run a few degrees—and in one case as much as twenty—out of the usual direction, varying from a southern course toward both the east and the west. And indeed it seems to me wholly impossible that a glacier, in a country like this, though of four or five thousand feet in thickness, and probably more along the coast, could have preserved everywhere over the uneven rocky bottom, an invariable direction in its movements. In its progress over, or down, our high hills, there would be a constant liability to local deflections, varying a little from the general course of the great glacier.

At the southern foot of this mountain lie vast boulders, torn from the great hill before them. They are identical in composition with the mountain, so that we here again see evidence that it was neither through the agency of icebergs, nor of polar currents, that those huge quartzose conglomerate boulders were detached from the mountain, removed the few hundred yards, and partially rounded during their limited transportation. One of these, lying at the southeastern base of the hill, can not weigh less than six hundred tons. The formation to the south and southwest of these hills is principally clay slate, called by the State geologists argillo-micaceous, and referred to the "Taconic" system. The striæ upon these rocks are developed in the most admirable manner. In places near the village of Camden, they may be traced up and down, over the tops and along the sides of the ledges, the striæ pointing directly toward the high hills on the north.

On examining the island of Mount Desert, which, like Vinalhaven, is composed of syenite and the argillo-micaceous slate,

there are similar boulder phenomena to those observed forty miles west among the Camden hills. These mountains which tower up near the eastern border of the great fiord of the coast attain the altitude of nearly two thousand feet. They rise very abruptly from the sea, and are about a dozen or fifteen in number. From the summit of these hills a view is presented of the great archipelago of the Penobscot Bay. From Bar Harbor on the northeast, in Frenchmen's Bay, to Bass Harbor on the southwest, in Blue Hill Bay, journeying around these mountains on the south, close to their base, for the distance of twenty miles, there is one continued display of drift striæ and granitic boulders. The scratches run boldly up to the foot of these hills; and the harbors and coves trending north and south, exhibit these striæ everywhere. I have never seen in any part of Maine, not even in the granitic region of Mount Katahdin, an elevation nearly six thousand feet high, a picture of greater desolation than is presented about the south side of these mountains. Standing amid these vast ruins, it is apparent that only the irresistible grasp of a glacier could have broken them off and carried them far away toward the south. Here, as elsewhere, the granitic boulders are larger and less angular as we approach the hills from the south. Among these boulders, rocks of other formations are rarely found; and these are from the slates to the north of the hills, having been carried over these elevations, not *around* them. Upon the northern declivities of these hills, the boulders are not so numerous nor so large as they are on the south, but are generally much worn; and like those on the south, they are syenitic, like the formation of the hills.

But besides the coves and harbors of this great island of Mount Desert, its ledges, headlands and ponds, (some of which last are large and deep,) all trend north and south in conformity to the course of the striæ. More than one of its deeper ponds are gouged out of the solid syenite, and we find no evidence of this having been done by any other agency than that of glaciers.

Beyond these hills to the north, for fifteen or twenty miles, over a comparatively level country, the Taconic slates again appear; and the detritus of these rocks have been but sparingly transported over the granitic formation of Mount Desert. I think it a safe conclusion that the rocks torn from the hills, the valleys and the plains of the country, were not generally removed to any great distance southward. We find indeed the fossiliferous rocks from the region beyond Katahdin, a hundred and fifty miles north, scattered over the islands of the coast; brought doubtless upon the more elevated parts of the glacier, rather than attached to or near its under surface, during their distant transportation. But these rocks are by no means abundant.

Upon Vinalhaven, as we leave one of the granitic quarries on

the western side of Carver's Harbor and pass along north toward the highest granitic hill in the town, there rises a series of terraces, one above another, along a north and south course, till they attain the altitude of 150 feet above the water. The highest ridge but one is seven hundred yards long, and fairly unbroken except in one place, where there is a breach forty yards long. This granitic wall nearly resembles some of the "Horsebacks" in the country, and a well trained horse might be safely led along its entire length. This wall descends toward the east and the large salt-water mill-pond, at various angles, from thirty and sixty to ninety degrees. Between this ridge and the one above, which is the highest, there is a depression fifty yards wide and from ten to twenty feet deep. The rock of many thousand tons has all been swept away to the south of it for 150 feet, where we meet again another slope, rising gradually toward the south till it attains the usual height of this elevated ridge.

I consider this dell as having been gouged out of the rock, as the most of our harbors, coves, and ponds have been, by glacial action. We see the hills not only curving easily to the north, and steep on their southern sides, but we find also that their east and west sides are abrupt. We know that this abruptness, in the southern part of Maine, must have been caused by denudation; not such a wearing away as slow moving icebergs would be likely to make, though hundreds of thousands had struck in the same place. And those east and west sides both low, and high up the hills, are often seen beautifully, never roughly, scored. I suppose that when an iceberg touches along the side of a submarine hill, it would be deflected like any floating body, by the continuation of the current around the hills; it could not uniformly chafe and scratch the rock in all its inequalities of wall; for we know that the sides of the bergs are not abundantly supplied with those stone-grooving tools necessary for the smoothing and scratching.

And, let me ask, by what means were those oblong and wedge-shaped boulders deposited in the peculiar manner in which we find them? They do not lie with their longer diagonals across the striæ, but were left by some agent *head on* in their course toward the south. Icebergs could not have dropped them thus, while the movements of a glacier would have compelled the boulder to take this wedge-shape form in many cases, and would have kept its base always directed forward in the line of its course.

If then there is evidence of a power so great, acting against the highest hills of the coast, even leaving over their summits indisputable marks of extensive denudation, we have reason to believe that the glacier which swept across them was of vast thickness. Had the glacier reached barely above the top

of the highest hill of the Mount Desert group, an elevation of 2000 feet, its action for ages might have indeed accomplished the rounding and sloping of the northern sides of those mountains; but the ice of a few hundred feet in thickness above their summits, could not have produced that vast amount of denudation required to form their southern brows. It is altogether probable that the glacier far overtopped the highest of the hills, and it is not unreasonable to suppose it to have been at least twice two thousand feet in thickness.

Moreover there is evidence that this glacier was not limited to this great fiord of Maine. It must have extended far toward the east and covered the country on the west. In fact, it was probably a part of the universal glacier which covered the continent wherever the drift striæ have been observed. But upon the discussion of this point I will not now enter.

ART. XXX.—*Contributions from the Sheffield Laboratory of Yale College.* No. VII.—*On the Indirect Determination of Potash and Soda;* by PETER COLLIER, B.A., Assistant in the Sheffield Laboratory.

THE method customarily employed in estimating potash and soda, viz: by the precipitation of the former as platinchlorid of potassium and reckoning soda from the loss, though sufficiently accurate in patient and skillful hands, is yet open to many sources of error and at the best is exceedingly tedious and troublesome.

The indirect method does not yet appear to possess the confidence of chemists, at least, it is rarely mentioned in published investigations. I have therefore, at the suggestion of Prof. Johnson, made a number of experiments to ascertain the limits of error in this process.

The volumetric estimation of chlorine as perfected by Mohr offers by far the best basis for an indirect determination of the alkalies. It is in fact requisite in employing the usual direct method, to procure the alkalies in the condition of pure chlorids before precipitation.

When the alkali chlorids are obtained free from all foreign matters, it is but the work of a few moments to ascertain their content of chlorine.

The silver solution used for this purpose is best prepared by weighing off in a porcelain crucible about 4·8 grm. of clean crystallized nitrate of silver, fusing it at the lowest possible heat, and then ascertaining its weight accurately. After fusion it should weigh *a little more* than 4·7933 grm., the quantity, that, contained in a liter of water, gives a solution of which 1 c. c. =

·001 grm. of chlorine. The fused salt is dissolved in a little warm water, the solution brought into a liter flask and filled to the mark, observing the usual precautions as to temperature, &c. When thus adjusted, add to the contents of the flask, from a burette, enough water to bring the excess of nitrate of silver above 4·7933 grms. to the requisite dilution. In this way it is easy with a burette and liter flask to make a perfectly accurate standard solution, while this would be hardly possible should the operator weigh off *less* than 4·7933 grm. of nitrate of silver.

This solution, which may be preserved in a well corked bottle indefinitely, without change, is next tested by means of a solution of pure chlorid of sodium or chlorid of ammonium, a quantity, say about 2 grams, of one of these salts being dissolved in a liter of water and 20 c. c. of the liquid taken for the comparison. The solution being ready, the estimation of chlorine is conducted as described by Mohr, Fresenius, Sutton and others, chromate of potash being employed to indicate the completion of the reaction. The use of Erdmann's float in a burette (which may hold 70 c. c.) graduated to fifths ensures the needful accuracy of reading. In my determinations $\frac{2}{10}$th c. c. of silver solution were deducted as the excess needed to produce a visible quantity of chromate of silver.

The appended table gives the results I obtained in the analyses of the chlorids of potassium and sodium. The salts were perfectly pure and the quantities were weighed out in each case. In order to test the method thoroughly I have varied the proportions of the mixtures from one extreme to the other.

Summary of Volumetric Chlorine Determinations.

	K Cl taken.	NaCl taken.	Cl found.	K Cl calculated.	NaCl calculated.	Cl calculated.
1st analysis.	·0582	- - - -	·02780	·05725	·00095	·02768
2nd "	·1668	- - - -	·07940	·16617	·00063	·07982
3rd "	·1507	- - - -	·07168	·15056	·00014	·07167
4th "		·0590	·03600		·06062	·03579
5th "	·0782	·0317	·05640	·07831	·03159	·05642
6th "	·0305	·0379	·03750	·03044	·03796	·03750
7th "	·0455	·0169	·03200	·04464	·01776	·03189
8th "	·0166	·0480	·03720	·01514	·04946	·03701
9th "	·0530	·0429	·05120	·05319	·04271	·05123
10th "	·0431	·0820	·07027	·04282	·08228	·07024
11th "	·0992	·0182	·05820	·09929	·01811	·05821
12th "	·0967	·0102	·05217	·09669	·01021	·05217
13th "	·0101	·1029	·06718	·01039	·10260	·06722
14th "	·1284	·0067	·06512	·12841	·00669	·06512
15th "	·0065	·1100	·06990	·00584	·11066	·06982

It may be seen from the above list of analyses, which includes all the determinations I have made, from first to last, for the purposes of this paper, that in no case does the difference between the quantities taken and found of either alkali chlorid exceed two milligrams, and in most instances it is less than one milligram. The correspondence between the amounts of chlorine

as taken and found is of course still more near. The errors that appear in the estimation of the chlorids would be considerably reduced, if, as usually happens, they were calculated as oxyds.

Here follow the formulæ which I have employed for calculating the quantities of NaCl and KCl, or of NaO and KO, contained in or corresponding to any mixture of alkali-chlorids whose total weight and amount of chlorine are known.

W = weight of mixed chlorids.
C = weight of chlorine.

$$NaCl = C \times 7{\cdot}6311 - W \times 3{\cdot}6288.$$
$$KCl = W \times 4{\cdot}6288 - C \times 7{\cdot}6311.$$
$$NaO = C \times 4{\cdot}0466 - W \times 1{\cdot}9243.$$
$$KO = W \times 2{\cdot}9243 - C \times 4{\cdot}8210.$$

The results I have obtained thus demonstrate that the indirect method is in all cases equal in accuracy to the ordinary separation, while in the matter of convenience and economy of time there is no comparison between them.

ART. XXXI.—*Contributions to Chemistry from the Laboratory of the Lawrence Scientific School;* by WOLCOTT GIBBS, M.D., Rumford Professor in Harvard University.—No. I.

1. *On the relations of hyposulphite of soda to certain metallic oxyds.*

THE employment of hyposulphite of soda as an analytical reagent was first suggested by Himly,[1] who in a short paper, intended only as a preliminary notice, pointed out the relations of this salt to solutions of arsenic, antimony, copper and platinum, and suggested its use as a general reagent in place of sulphydric acid. Himly's paper attracted little attention and was soon forgotten. The subject was again taken up at about the same time by Vohl[2] and Slater[3] who appear to have been unacquainted with Himly's results. Vohl's investigation embraces the action of the hyposulphite upon solutions of arsenic, antimony, tin, copper, mercury, silver, gold, platinum, lead, bismuth, and cadmium. Slater studied the action of the salt upon solutions of chromium in the form of chromic acid, arsenic, antimony, copper, bismuth, lead, and mercury, as well as upon ferridcyanid, ferrocyanid, and cyanid of potassium, and upon sulphocyanid of iron and hypermanganate of potash. The results obtained by these chemists differ in some particulars, especially as regards copper and lead. More recently Chancel[4] has employed the hyposulphite for the separation of alumina from iron, and Stro-

[1] Annalen der Chemie und Pharmacie, xliii, 150. [2] The same, xcvi, 237.
[3] Chemical Gazette, 1855, 369. [4] Comptes Rendus, xlvi, 987.

meyer[5] has extended the same process to the separation of iron from titanic acid and zirconia. Other analytical applications of the hyposulphite have been made in which the salt is employed either as a solvent or in volumetric processes: these do not require notice in this place. The following observations on the behavior of the hyposulphite toward certain metallic salts are interesting from a purely chemical rather than from an analytical point of view.

Nickel.—When a neutral solution of sulphate, chlorid or nitrate of nickel is boiled with a solution of hyposulphite of soda, a black precipitate of sulphid of nickel is thrown down, and after very long boiling the precipitation is complete and the solution is free from nickel. If the solution of nickel be previously acidulated by the addition of a drop or two of acetic acid the precipitation is more rapid. It is very difficult to determine the exact point at which the solution ceases to contain nickel; the boiling must usually be continued for several hours. When chlorhydric acid is added to the mixed solutions of nickel salts and hyposulphite, no precipitate is produced on boiling: in this case nickel behaves like iron and the other metals of the same group: in the cases first mentioned its analogies are with copper. The presence of free ammonia does not prevent the precipitation of sulphid of nickel but the action goes on very slowly. Rammelsberg[6] long since observed that a solution of hyposulphite of nickel is partially decomposed by evaporation, and that the dry mass on heating yields a yellow sulphid of nickel: the same is true of a mixed solution containing sulphate of nickel and hyposulphite of soda.

The formation of sulphid of nickel, which takes place slowly in solutions evaporating or boiling under ordinary atmospheric pressure, is facilitated in an extraordinary degree by heating in closed tubes to a temperature of 120° C. Ordinary combustion tubes answer the purpose very well: the tube is first closed at one end and then drawn out near the other end to a narrow neck. The solution of nickel is introduced by a long funnel together with the solution of hyposulphite which should be in excess and concentrated. After sealing the tube before the blast-lamp it is to be heated in an air-bath and kept for half an hour at a temperature of about 120° C. Every trace of nickel is thrown down in the form of sulphid mixed with free sulphur: the tube may then be opened at the point, the liquid allowed to flow into a beaker, the tube cut across and the sulphid of nickel washed out. It may be thrown on a filter and washed with boiling water without oxydizing in the smallest degree. The equation representing this reaction appears to be

$$NiCl + 2NaO, S_2O_2 = NiS + NaCl + NaO, S_3O_5.$$

[5] Ann. der Chem. und Pharm., cxiii, 127. [6] Pogg. Ann., lvi, 295.

This process answers extremely well for the analysis of nickel salts and gives more accurate results than the precipitation of the nickel as oxyd by caustic potash: it also requires less time since the sulphid may be washed with the greatest ease. On the other hand, as I shall show, it is of very limited application as a means of separating nickel from other metals. The sulphid of nickel precipitated by heating with solution of hyposulphite of soda appears black at first, but after ignition has a dark bronze yellow color. It is unchangeable in the air, and may be boiled with strong chlorhydric acid without being sensibly attacked. Strong sulphuric acid exerts no action upon it: nitric acid oxydizes it to sulphate of nickel. It may be heated in a covered porcelain crucible without oxydation, but by roasting in a current of air is converted into a basic sulphate. For quantitative purposes it is best, after washing and drying the sulphid, to burn it with the filter in a porcelain crucible so as to convert it into basic sulphate, to add to this a few drops of sulphuric acid, evaporate to dryness and gently ignite the resulting neutral sulphate, from the weight of which the nickel may be calculated. The sulphate must be completely soluble in hot water. Rose has shown that the sulphate may be completely converted into oxyd by strong ignition.[7]

Cobalt.—The relations of cobalt to hyposulphite of soda are almost identical with those of nickel; the only marked difference consists in the much greater difficulty with which cobalt is precipitated. In fact a complete precipitation under the ordinary atmospheric pressure is almost impossible. In a sealed tube, at a temperature of 120° C., the precipitation is complete in an hour at farthest. The sulphid is black, and is almost if not quite as insoluble in acids as the sulphid of nickel; it may be washed upon a filter with boiling water, and does not oxydize in the air. When heated to redness in contact with air it is readily oxydized to sulphate of cobalt, which is not basic unless the temperature is very high. In all cases, however, it is best to treat the roasted sulphid with a few drops of sulphuric acid, evaporate and ignite gently. The cobalt may then be calculated from the weight of the sulphate. Cobalt may be easily determined quantitatively in soluble neutral salts by this process; as in the case of nickel, however, the hyposulphite of soda serves to separate cobalt from other metals only in a very limited number of cases. Nickel and cobalt are completely precipitated together as sulphids by hyposulphite of soda at 120° C.: it is best to weigh them together as sulphates and then determine the cobalt by Stromeyer's method as modified by Dr. Genth[8] and myself; the nickel is then found by simply subtracting the weight of the sulphate of cobalt from that of the mixed sulphates.

[7] Pogg. Ann., cx, 132.

[8] This Journal, [2], vol. xxiv, p. 86.

Iron.—A solution of peroxyd of iron becomes of a deep violet color upon the addition of hyposulphite of soda; after a short time the color disappears and the iron is reduced to protoxyd. According to Fordos* and Gélis, the reaction which takes place in this case is represented by the equation

$$Fe_2Cl_3 + 2NaO.S_2O_2 = NaCl + 2FeCl + NaO, S_4O_5.$$

A solution of a protosalt of iron may be boiled or evaporated with hyposulphite of soda without undergoing any perceptible change. When, however, the two solutions are heated together for an hour or more to a temperature of 130°–140° C., the hyposulphite of soda being in excess, the whole of the iron is thrown down as a black sulphid, which is not oxydized by exposure to the air, and is not sensibly dissolved by strong chlorhydric acid. Nitric acid readily oxydizes it; dilute sulphuric acid has no sensible action. The complete precipitation of iron as sulphid under these circumstances requires a longer time and a higher temperature than that of either cobalt or nickel: the sulphid is the protosulphid, FeS, and is readily oxydized to sesquioxyd by ignition in a current of air. When sesquioxyd of iron, which has been strongly ignited so as to be with difficulty soluble in acids, is mixed with an excess of dry hyposulphite of soda and heated to redness, a black sulphid is formed which is readily soluble in chlorhydric acid with evolution of sulphydric acid gas. Nickel and cobalt give insoluble sulphids under the same circumstances, nevertheless I have not found it possible to separate iron quantitatively from either of the other two metals by this process. From what has already been stated it will also be evident that heating with solutions of the hyposulphite also fails to separate iron from cobalt and nickel.

Alumina.—A dilute solution of alumina, according to Chancel, is completely precipitated by long boiling with hyposulphite of soda, as a hydrate which is easily washed. The reaction is here expressed by the equation

$$Al_2O_3, 3SO_3 + 3NaO, S_2O_2 + 3HO = Al_2O_3, 3HO + 3NaO, SO_3 + 3SO_2 + 3S.$$

The boiling must be continued until the whole of the sulphurous acid is expelled. Chancel applies this reaction to the quantitative separation of alumina from iron, but I have always found that the complete precipitation of the alumina is, to say the least, extremely difficult. This may be due to the formation of a sulphite which is not decomposed by boiling. When a solution of alum is heated to 120° C. with a strong solution of hyposulphite of soda the whole of the alumina is precipitated after a short time, as a hydrate mixed with sulphur. The precipitate is white and of a peculiar semi-gelatinous character; it is more easily washed than the ordinary hydrate thrown down by ammonia. It

* Ann. de Chimie et de Physique, viii, 351.

is almost completely insoluble in cold and strong chlorhydric acid but is slowly dissolved by boiling. Dilute sulphuric acid has no action upon it: strong sulphuric acid and nitro-muriatic acid dissolve it with difficulty.

Zinc.—When solutions of sulphate of zinc and hyposulphite of soda are heated together in a closed tube to 120° C.–140° C., the zinc is partially precipitated as a yellowish white powder, which is a mixture of sulphid of zinc and free sulphur. A large quantity of zinc remains in solution.

Manganese.—Sulphate of manganese and hyposulphite of soda may be heated together to 120° C. without any apparent action. When however iron is present, the precipitated sulphid of iron always contains manganese which cannot be separated from it by acids.

The insolubility of the sulphids of cobalt and nickel when precipitated in the manner above described at high temperatures led me to examine the behavior of the sulphids when precipitated under ordinary atmospheric pressure from boiling solutions. When a boiling solution of sulphid of sodium is added to a boiling solution of sulphate of nickel or cobalt, the sulphids are completely precipitated in such a state of aggregation that they may be thrown upon a filter, washed with boiling water, and dried in the air without the least oxydation. It is well before filtering to render the liquid slightly acid so as to avoid free sulphid of sodium; acetic acid answers best for this purpose. The sulphid of nickel or cobalt, or the mixed sulphids, may be converted into sulphates and weighed as such.

2. *On the determination of nitrogen by weight.*

Bunsen[10] has given a method of analyzing nitrates and nitrites which renders it possible to determine all the constituents of the salt in a single analysis. This method consists essentially in igniting the salt in an atmosphere of nitrogen gas, absorbing the oxygen evolved by metallic copper, and collecting the water in a chlorid of calcium tube. The nitrogen in the salt is given by the loss of weight in the apparatus.

In those analyses of nitrates or nitrites in which it is only desired to determine the nitrogen, the following process may be employed with advantage. A hard glass tube, about six inches in length, is sealed at one end, and its volume determined by filling it with mercury and pouring this into a graduated vessel. The tube is to be carefully dried and weighed with a good cork: it is then to be filled with finely divided metallic copper, prepared by reduction of the oxyd, so as to enable the operator to judge of the quantity necessary. The salt to be analyzed is then weighed and mixed with the metallic copper, either in a

[10] Ann. der Chemie und Pharmacie, lxxii, 40.

mortar or with a mixing wire in the tube, and the tube with its contents and cork is again weighed. The weight of the copper employed is thus known and its volume may then be found by dividing this weight by the density of metallic copper. A weighed chlorid of calcium tube is then adjusted as in organic analysis, and the combustion tube is heated in the usual manner. When the combustion is finished, the open end of the chlorid of calcium tube is sealed with the blowpipe flame and the combustion tube allowed to become perfectly cold. The chlorid tube is then removed and weighed, and the combustion tube also weighed with its cork. The increase in weight of the chlorid of calcium tube gives the amount of moisture in the copper and the water in the salt analyzed. The loss of weight in the combustion tube gives the nitrogen in the salt after correction for the oxygen in the tube, for the moisture in the copper, and for the water in the salt. The correction for the oxygen in the combustion tube absorbed by the copper is easily found, with a sufficiently close approximation, by subtracting the volume of the copper from that of the tube, finding the weight of the residual air, taking one-fifth of this as oxygen, and considering the whole of this oxygen as absorbed by the copper. A piece of asbestos may be placed between the copper and the cork with advantage, but this renders an additional correction necessary. Two analyses were executed by this method. In the first a sample of pure saltpetre gave 13·86 per cent nitrogen; the formula KO, NO_5 requires 13·86 per cent. In the second a specimen of the commercial salt gave 13·7 per cent nitrogen, while the same salt analyzed by Simpson's method, in which the volume of the nitrogen is determined, also gave 13·7 per cent. The whole analysis, with the weighings, may easily be executed in an hour and a half by a single person. It is easy to see that this method applies to all inorganic nitrates and nitrites, whether hydrous or anhydrous, but that it can not be employed in the case of organic or ammoniacal salts. In the analysis of inorganic nitrates or nitrites by Simpson's method, it is not necessary to use oxyd of mercury to prevent the formation of deutoxyd of nitrogen. In all such cases it will be found sufficient to mix the salt with pure metallic copper. In this manner the dimensions of the combustion tube may be greatly diminished. I have also found it advantageous to pump out the air from the combustion tube by a small hand air-pump before disengaging carbonic acid from the carbonate of manganese. By alternately pumping and filling the tube with carbonic acid the air may be completely expelled before the combustion commences. It is also better to draw the tube out before a Bunsen's gas-blast, as it is difficult to make a cork and india-rubber connector perfectly tight. With a little practice the drawing out is easily effected

even with the hardest combustion tubes. Where many nitrogen determinations are made it will be found convenient to employ printed forms for logarithmic calculation, the logarithmic constants of reduction being printed upon the form itself in their proper places.[11]

8. *On the separation of Cerium from Didymium and Lanthanum.*

The methods which have been recently proposed for the separation of cerium from lanthanum and didymium are familiar to chemists, and do not require recapitulation in this place. They all depend, like the older methods, upon the oxydation of cerium to a sesquioxyd or to Ce_3O_4, and upon the formation of insoluble basic salts of the sesquioxyd. No one of these methods effects a complete or quantitative separation, though all afford means of obtaining salts of cerium in a state of chemical purity. The following observations upon this subject are believed to be new. When a salt of cerium, lanthanum, and didymium is boiled with dilute nitric acid, and peroxyd of lead added to the solution, the cerium is quickly, and under some circumstances completely, oxydized, the solution becoming more or less deeply orange-yellow. This process affords an extremely simple and delicate test for cerium; it succeeds with all the salts which are soluble in nitric acid, though of course when the mixed oxalates are tested the oxalic acid is oxydized to carbonic acid before the characteristic cerium-yellow appears. For the purpose of testing it is sufficient to dissolve the salt to be examined in nitric acid diluted with its own volume of water, to add a small quantity of pure peroxyd of lead and boil for a few minutes, when the smallest trace of cerium can be detected by the yellow color of the solution. The reaction is here exactly analogous to that of nitric acid and peroxyd of lead with solutions of manganese, which last is oxydized, not as Crum supposed, to hypermanganic acid, but, as Rose has shown, to sesquioxyd.

When a solution containing a salt of cerium dissolved in strong nitric acid is boiled for a short time with a large excess of peroxyd of lead, oxygen gas is copiously evolved, and at the same time the sesquioxyd of cerium formed at first is completely reduced to protoxyd, the solution becoming perfectly colorless. The remarkable reaction which occurs in this case appears to be connected with the formation of nitrate of lead, since, when the solution of protoxyd of cerium contains a large excess of this salt the cerium is not peroxydized by boiling with nitric acid and the peroxyd. Solutions of cerium salts are also oxydized by boiling with peroxyd of lead and dilute sulphuric acid, but

[11] Such printed forms may be had from the publishers of this Journal at an almost nominal price.

the protoxyd of cerium in the nearly insoluble double sulphate of soda and the cerium metals is only partially oxydized by heating with strong sulphuric acid and peroxyd of lead although oxygen is freely evolved.

A solution of hypermanganate of potash has no immediate action upon a solution of protoxyd of cerium either in nitric or in sulphuric acid, the violet color remaining unchanged even in a hot solution. On boiling for some time, however, the color changes slowly, the solution gradually becomes yellow and a brown flocky precipitate is thrown down, which consists of hydrate of sesquioxyd of manganese.

According to Stapff, a solution of hypermanganate of potash is immediately decolorized by a solution of the sulphate of potassium and protoxyd of cerium in chlorhydric acid, but after some time chlorine is evolved and the sesquioxyd of cerium found is reduced to protoxyd. It is clear that in this case the oxydizing agent is chlorine. The further investigation of this subject was committed to Dr. T. M. Drown, who has obtained the following results.

When a solution of cerium, didymium, and lanthanum, is treated with nitric acid and peroxyd of lead in the manner pointed out above, the deep orange colored liquid evaporated to dryness, and heated for a short time to a temperature sufficiently high to expel a portion of the acid, it will be found that boiling water acidulated with nitric acid dissolves only the salts of lanthanum and didymium, leaving the whole of the cerium in the form of basic nitrate, insoluble in water. The insoluble matter is to be filtered off and thoroughly washed. A current of sulphydric acid gas passed into the filtrate removes the lead, after which the lanthanum and didymium may be precipitated together as oxalates, which if the process has been carefully performed, are perfectly free from cerium. The mass on the filter is readily dissolved by fuming nitric acid. Sulphydric acid is then to be passed through the solution sufficiently diluted with water until the lead is completely precipitated. The cerium may then be thrown down by oxalic acid, ignited and weighed as Ce_3O_4, or as sulphate. In this manner Dr. Drown obtained in four analyses of the same salt

DiO and LnO = 24·84, 25·31, 25·54, 24·65 per cent.

Nitrate of protoxyd of cerium obtained by this process gives, when tested by the spectroscope with transmitted light, even in very thick layers, a scarcely perceptible indication of didymium. I may here mention that Gladstone's lines furnish, with proper care, the most delicate test for the presence of didymium which we possess. It is only necessary to transmit the light through very thick layers of liquid and to employ a condensing lens so

as to throw the transmitted light directly upon the slit of the spectroscope.

4. *On the separation and estimation of cerium.*

The precipitation of cerium in the form of oxalate from a slightly acid solution is unquestionably the most satisfactory method of separating the oxyd. The estimation of the oxalate upon a weighed filter is accompanied with the usual trouble and loss of time in perfectly drying the filter before and after collecting the precipitate upon it. By the following mode of proceeding, these difficulties may be easily and completely avoided. The solution of cerium, (I understand here the usual mixture of cerium, lanthanum and didymium,) when neutral, is to be rendered slightly acid by sulphuric or chlorhydric acid and then largely diluted with water. Half a litre of water for every estimated gramme of oxyd is a good working proportion. The solution is then to be boiled and a hot solution of oxalic acid or oxalate of ammonia added. On cooling, especially when the solution has been well stirred with a glass rod, or shaken, the oxalate separates in large crystalline grains of a pale rose-violet color. The precipitate is to be filtered off and well washed with boiling water, the washing being extremely easy in consequence of the coarse granular character of the precipitate. The filter is then to be pierced and the oxalate carefully washed down into a crucible, after which the water in the crucible may easily be removed by evaporation and the oxalate dried at a temperature of 100° C. The equivalents of lanthanum and didymium are so near to that of cerium that no very sensible error is committed by considering the mixed oxalates as consisting simply of $CeO\ C_2O_3 + 3$ aqs. In mineral analyses in which the relative quantity of oxygen in the acids and bases must be determined with accuracy, it may be desirable to ascertain the quantity of oxalic acid in a weighed portion of the oxalates by combustion with oxyd of copper. From this the acid in the entire precipitate may be found, and the oxygen in the three bases will then be one-third of the oxygen in the acid.

5. *On the quantitative separation of cerium from yttrium, aluminum, glucinum, manganese, iron and uranium.*

The relations of the three metallic oxyds of the cerium group to sulphate of potash have long been familiar to chemists, and have furnished methods of separation from other oxyds which are still in use. In examining this subject I have found that sulphate of soda possesses great advantages over sulphate of potash, the double sulphates of sodium and the protoxyds of cerium, lanthanum and didymium, being absolutely insoluble in a saturated solution of sulphate of soda. On the other hand, the

double sulphates of sodium and glucinum, aluminum, yttrium, protoxyd of iron, and sesquioxyd of uranium, are readily soluble in sulphate of soda and may easily be washed out from the highly crystalline insoluble double sulphates of the cerium group. In the analysis of minerals in which cerium occurs with one or more of the other oxyds, the following method may be employed with great advantage. The oxyds are to be brought into the form of sulphates, dissolved in the smallest quantity of water, and a saturated solution of sulphate of soda added, together with a sufficient quantity of the dry sulphate in powder, to saturate the water of solution. It is most advantageous to use hot solutions. The insoluble double sulphates of soda and the cerium metals separate immediately, as a white, highly crystalline powder, which is to be brought upon a filter and thoroughly washed with a hot saturated solution of sulphate of soda. After washing, the double sulphates upon the filter are to be dissolved in hot dilute chlorhydric acid, the solution largely diluted with water, and the cerium metals precipitated by oxalate of ammonia, in the manner already pointed out (4). From the filtrate, the oxyds of the yttrium group may be precipitated at once by oxalate of ammonia, after peroxydizing the iron by means of chlorine water, and rendering the solution slightly acid with chlorhydric or sulphuric acid. The only precaution to be taken in this process is to reduce the iron completely to the form of protosulphate before precipitating the cerium with sulphate of soda. This is best accomplished by means of a current of sulphydric acid gas passed into the hot solution. The precipitated sulphates always contain iron when this precaution has been neglected. This iron is easily detected in the filtrate from the oxalates, and may be precipitated by ammonia and added to that obtained from the main solution.

6. *On the employment of fluohydrate of fluorid of potassium in analysis.*

The facility with which the double fluorid of titanium and potassium, or fluotitanate of potassium, separates in a crystalline state from hot aqueous solutions, on cooling, suggested to Wöhler the best method at present known for obtaining pure titanic acid. In Wöhler's process, rutile or titaniferous iron is fused with an excess of carbonate of potash, the fused mass treated with water, which leaves the greater part of the iron undissolved and the filtrate saturated with fluohydric acid. By recrystallization the fluotitanate TiF_2 KF, or perhaps more correctly, Ti_2F_4, 2KF, may be obtained in white, scaly crystals, resembling boric acid; from this salt pure titanic acid is easily obtained by precipitation with ammonia. Marignac modified this process very advantageously in the treatment of zircon to obtain pure zirconic

acid. The zircon was fused with fluohydrate of fluorid of potassium directly. In this manner a perfect resolution of the mineral was easily obtained; the fluozirconate of potassium was then dissolved out from the insoluble fluosilicate by hot water, acidulated with fluohydric acid. The observations of Wöhler and Marignac suggested to me a further extension of the same process, the general result of the investigation being that fluohydrate of fluorid of potassium or sodium may be employed with great advantage in resolving minerals containing metallic oxyds of the types RO_2 and R_2O_3. The special results are as follows.

Glucinum.—Glucina, purified from iron and aluminum by the usual methods, is to be fused with twice its weight of fluohydrate of fluorid of potassium, and the fused mass treated with boiling water, to which a small quantity of fluohydric acid has been added. On filtering a notable quantity of the insoluble fluorid of aluminum and potassium almost always remains upon the filter, even when the separation from glucinum has been carefully executed, by means of carbonate of ammonia. The filtrate, on cooling, deposits colorless transparent crusts of the double fluorid of glucinum and potassium which are easily purified by recrystallization. This method affords the simplest—I am almost disposed to say the only—method of obtaining a chemically pure salt of glucinum. The double salt is apt to contain an excess of fluorid of potassium. To obtain it perfectly pure for analysis, Mr. J. C. Newbery fused the fluohydrate of potassium with an excess of glucina. The salt as thus obtained gave him

	Calculated.	Found.
Glucinum, - - - - -	5·74	5·70
Potassium, - - - - -	47·73	47·76
Fluorine, - - - - -	46·53	46·50
	100·00	99·96

which corresponds precisely with the formula G_2F_3+3KF, if glucinum be taken as 7, or with GF+KF, if glucinum be taken as 4·66. In this analysis the fluorine was estimated by the loss. Berzelius gives the formula G_2F_3+3KF. Glucina may be obtained directly from beryl, as Mr. Newbery[12] has found, by fusing the finely pulverized mineral with fluohydrate of potassium, dissolving out the soluble double fluorid of glucinum and potassium, and purifying by recrystallization. As, however, beryl contains only 13 or 14 per cent of glucinum, this process is not economical. It is better to separate the other oxyds as far as possible by the ordinary methods and then to purify the crude glucina by the process above pointed out. It is perhaps worthy of notice that while almost all proto- and sesquioxyds give insol-

[12] Prof. Joy had already remarked that beryl may be completely resolved by fusion with fluorid of potassium. See this Journal for July, 1863.

uble double salts with fluorid of potassium, the fluorid of glucinum behaves like a bifluorid, so as to suggest that glucina may possibly be GO_2 instead of GO or G_2O_3. Ammonia precipitates glucina directly from the solution of the double fluorid. When a solution of fluorid of sodium is added to one of aluminum and glucinum, the whole of the aluminum is thrown down in the form of cryolite, Al_2F_3, 3NaF, while the glucinum remains in solution. It is probable that this method will give accurate quantitative results.

Hyponiobic acid.—I am indebted to the kindness of Prof. B. Silliman, Jr., for a liberal supply of columbite from Middletown, Connecticut. Mr. F. W. Tustin has found that the finely pulverized mineral treated with a solution of three times its weight of fluohydrate of potassium is almost completely resolved during the mere process of evaporation to dryness. The dry white powder thus obtained by fusion in a platinum crucible gives a beautiful rose-colored mass which is easily separated from the crucible, and which in a moist atmosphere falls to a crystalline powder. On boiling with water acidulated with fluohydric acid a clear solution is obtained, from which, on cooling, hypo-fluoniobate of potassium separates in colorless crystals. By repeated crystallization, the salt may be obtained free from iron and manganese, but containing an excess of fluorid of potassium. It is better, however, to pass a current of sulphydric acid gas through the solution to remove traces of tin and tungsten and reduce the iron to proto-fluorid and afterward to evaporate and crystallize.

When the object in view is simply to prepare perfectly pure hypo-fluoniobate of potassium, it is better to fuse one part by weight of columbite with two of fluohydrate of potassium. The fused mass has then a greenish tint. It must be rubbed to very fine powder before boiling with water acidulated with fluohydric acid. After passing sulphydric acid gas through the solution and filtering, the hypo-fluoniobate crystallizes in colorless acicular crystals which must be purified by repeated crystallization. The salt is much more soluble in hot than in cold water. In this process a considerable quantity of fluosilicate of potassium, fluorid of calcium, quartz, and other impurities, usually remain upon the filter, with the sulphids of tin and tungsten. The difficulty in this process consists in separating the iron, when, as in the mineral columbite, this is present in comparatively large quantity. In this case very large platinum or silver vessels and numerous recrystallizations become necessary. It is better, therefore, in preparing large quantities of pure hyponiobic acid to fuse with fluohydrate of potassium, dissolve the fused mass in water as before, and filter to separate quartz, fluosilicate of potassium and fluorid of calcium, evaporate the solution to dryness and heat with pure sulphuric acid until the whole of the fluorine

is expelled. By diluting with water and boiling, the whole of the hyponiobic acid is precipitated. If after the precipitation rochelle salt is added, and the whole is boiled, the hyponiobic acid will be almost completely free from iron, manganese, tungsten and tin. After thorough washing, it may be again fused with fluohydrate of potassium, and the double fluorid obtained perfectly pure by recrystallization.

Chromic iron ore.—Mr. P. C. Dubois has found that the finely pulverized ore may be completely resolved by fusing it at a red heat for ten or fifteen minutes over a blast lamp with four or five times its weight of fluohydrate of potassium. The fused mass has a clear green color. By treating this with sulphuric acid until the whole of the fluorine is expelled, and then adding water, the chromium iron and aluminum are completely dissolved as sesquisalts. Perhaps the easiest method of separation is the following. To the solution an excess of caustic soda is added, after which, without filtering, chlorine gas is to be passed through until the sesquioxyd of chromium is converted into chromic acid. The solution is then to be heated to expel excess of chlorine, nitric acid added in slight excess, and the sesquioxyd of iron and alumina precipitated by ammonia. To the filtrate, acetic acid is to be added in small excess, after which the chromic and sulphuric acids may be precipitated together by acetate of lead. The precipitate after washing is to be boiled with chlorhydric acid and alcohol, the lead separated as chlorid and the chromium determined in the usual manner as sesquioxyd. This method gives a complete separation, even when magnesia and nickel are present in the ore.

Tinstone.—Mr. J. W. B. Hallett has found that tinstone is very easily resolved by fusion with three or four times its weight of fluohydrate of potassium. The mineral must be finely pulverized. The fused mass may be treated directly in the crucible with sulphuric acid to expel fluorine, after which, by adding water, filtering and boiling the filtrate, the whole of the tin may be thrown down as stannic acid, which is to be separated from traces of iron in the usual manner. This method of resolving the ore of tin is very much more convenient than fusion with caustic alkalies, or with sulphur and carbonate of soda.

From what has been said it will appear that fluohydrate of potassium possesses peculiar advantages in resolving those minerals which contain metallic acids of the type RO_2 or hyponiobic acid. The salt is easily prepared in a state of purity and may be preserved in vessels of lead or of vulcanized india-rubber or gutta-percha.

Cambridge, Mass., Jan. 18th, 1864.

ART. XXXII.—*On Shepard's Paracolumbite;* by Mr. F. PISANI of Paris.[1]

PROFESSOR SHEPARD has given the name Paracolumbite to a black mineral found in small grains, or irregular seams, in the granite of Taunton, Massachusetts. According to a qualitative examination made by this mineralogist, paracolumbite contains fluohydric acid, iron and uranium, but no titanic acid.

Having at my disposition authentic specimens of this substance, received from the author himself, I have been able to study its chemical composition. I have thus ascertained, that the paracolumbite is nothing more than a titaniferous iron, mixed with a little gangue, from which it is extremely difficult to separate it entirely by mechanical means. The mineral occurs in black granules that on pulverization give an equally black powder. Hardness 4·5. Density 4·353. Before the blowpipe fuses to a black magnetic globule. Partially attacked by chlorhydric acid, and this solution heated with tin gives a violet color. Entirely decomposed by prolonged heat with concentrated sulphuric acid; the addition of cold water gives a solution which on boiling becomes cloudy with deposition of titanic acid. Shepard,[2] on the contrary, states the solution obtained by decomposition with sulphuric acid is not rendered milky by boiling, and that the metallic acid contained in paracolumbite is not titanic acid.

A quantitative analysis made by attacking the substance with bi-sulphate of potash gave the following results:

Titanic acid,	35·66
Ferrous oxyd,	39·08
Ferric oxyd,	3·48
Silica and insoluble,	10·66
Alumina,	7·66
Lime,	2·06
Magnesia,	1·94
	100·54

Deducting from the analysis the silica, alumina and lime which belong to the gangue, it is obvious that the mineral is an ordinary titanic iron. Paracolumbite cannot therefore be considered a distinct mineral species. It is identical with titanic iron.

[1] Communicated by the author. Paris, (France,) Feb. 4th, 1864.

[2] Mineralogy, 2d edition, (1857,) page 287.

ART. XXXIII.—*On the Cretaceous and Superior Formations of West Tennessee;* by JAS. M. SAFFORD, Lebanon, Tenn.

IN this article I propose to enumerate and describe briefly, so far as my examinations will permit, the Cretaceous and higher formations of West Tennessee. But before commencing with the lowest in order, it will be well to notice first the formation of *gravel* that is so common and conspicuous in the *Western Valley of the Tennessee river*,[1] and that rests upon all the formations occurring in this region excepting the alluvium of the bottoms.

The Western Valley Gravel.—This formation is, by no means, continuous over the whole area to which it belongs. It occurs in patches, or detached beds, depending much, in this respect, upon the nature of the surface on which it rests, and upon the extent to which it has been denuded. The beds, however, often cover locally large areas, the observer travelling upon them without a break for many miles. Their thickness is not great, rarely exceeding fifty or sixty feet, and being generally much less.

This gravel was doubtless deposited after the valley had received, for the most part, its present general form. Its beds are found upon the bluffs of the river, upon the uplands back of the bottoms and upon comparatively high ridges, being always the uppermost formation. It is often seen as far back as eight or ten miles from the river on both sides. On the eastern side it extends farther, and frequently caps the very high ridges of this part of the State, some of which are 800 feet above the sea. In this direction it extends, at some points, a few miles beyond the limit that I have given to the Western Valley. In a northerly and southerly direction, it skirts the river all along, on both sides, from Alabama and Mississippi to the Kentucky line.

The materials of the formation are water-worn siliceous pebbles with more or less sand, the latter, however, not prominent. The pebbles have been derived mostly from Carboniferous rocks. The worn pebbles are sometimes locally mingled with angular cherty fragments; but in such cases the beds are in the vicinity of Paleozoic rocks, the known source of the angular chert. Not unfrequently masses of the gravel may be seen cemented, usually by oxyd of iron, into heavy blocks of coarse conglomerate. At some of the iron-ore banks within the limits of this formation, we find sections presenting mingled masses of worn pebbles, angular chert, and hematite in irregular fragments and in "pots," the masses occasionally cemented into solid blocks.

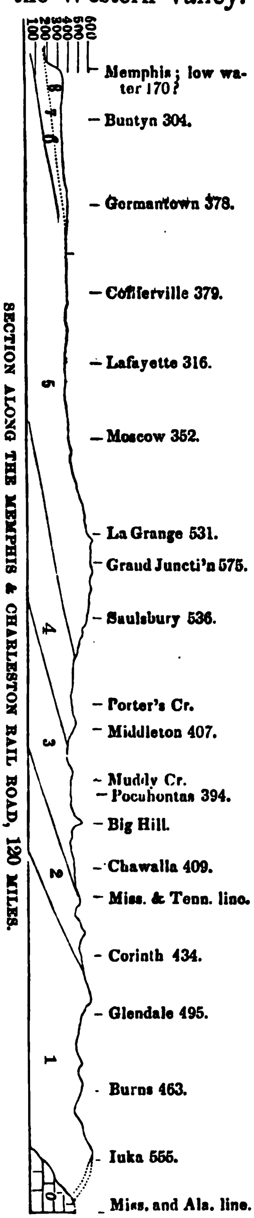
[1] Or simply the *Western Valley*. I give this name to the comparatively narrow and broken valley through which the Tennessee flows in its course from Alabama to Kentucky.

The exact age of this formation is not known. It is certainly of later date than the Cretaceous beds in the Western valley. It may be synchronous with the gravel of the Mississippi bluffs; but of this I have no satisfactory proof.[1] (This gravel is not indicated on the map. It is represented in the section at its eastern end by the group of dots.)

Excepting the Paleozoic rocks and the gravel just noticed, the distinctive groups of West Tennessee may be designated as follows:

9. *Bottom Alluvium*,	Modern.
8. *Bluff Loam*,	Post-tertiary.
7. *Bluff Gravel*,	" "
6. *Bluff Lignite*, (provisional),	Tertiary ?
5. *Orange Sand*, or *La Grange Group*,	Tertiary.
4. *Porter's Creek Group*, (provisional),	" ?
3. *Ripley Group*, (provisional),	Cretaceous.
2. *Green Sand*, or *the shell-bed*,	"
1. *Coffee Sand*,	"

SECTION ALONG THE MEMPHIS & CHARLESTON RAIL ROAD, 120 MILES.

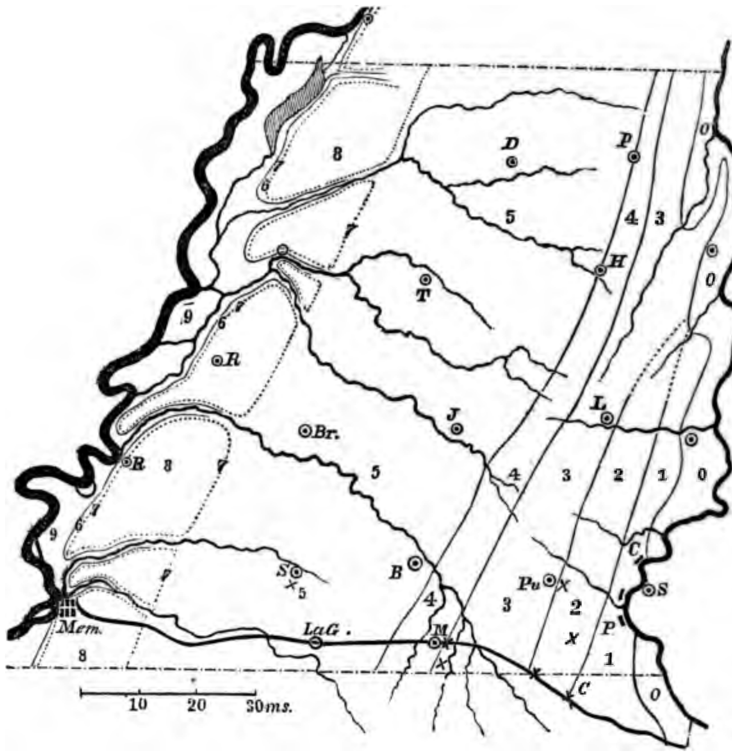


[1] At no point in Tennessee have I seen gravel running under the Cretaceous beds. In northeastern Mississippi I have observed some doubtful evidences of this. Should such beds be found it will make the gravel of different ages. In the latter case, a portion of the deposits might be regarded as the remains of the ancient shingle of the Cretaceous sea, or estuary. So far, however, as my observations have extended, I am compelled to refer all the deposits, in Tennessee at least, to the same epoch.

As to the waters which brought and deposited this gravel, the impressions received in the field are that its presence is due to the former existence of a large and powerful stream occupying the Western Valley, and perhaps flowing from the north, but having little or no connection in Tennessee with the water of the immediate valley of the Mississippi, the two valleys and their waters having been separated by the highlands or plateau of West Tennessee. In Kentucky and Mississippi, in one or both, these bodies of water may have united.

Drs. Harper and Hilgard, in their respective Mississippi Reports, associate this gravel with a superficial but very general formation to which they give the name of "*Orange Sand.*" This, they state, overlies the greater part of the State of Mississippi, and conceals, to a great extent, many of its more normal formations. The name *Orange Sand* was originally applied by me to a provisional series of strata for the most part equivalent to Hilgard's *Northern Lignitic*. With the exception of the gravel described above, I am not prepared to admit the existence in Tennessee of the "*Orange Sand*" as understood by them.

On the map and in the section accompanying this article the areas occupied respectively by these beds are laid off, and are numbered as above.[1]



The Paleozoic rocks occupy a narrow irregular belt, (marked *o*, *o*, upon the map,) averaging about five miles in width, and lying along the western side of the Tennessee river. This belt is interrupted near the southern part of the State, in Hardin county, the river bending to the west and striking the *Coffee sand*. Within it are beds of the *Hudson*, *Niagara*, *Lower Helderberg*, *Genesee*, (*Black Slate*,) and *Sub-carboniferous* epochs. I do not, however, propose to dwell upon these here, and therefore pass on to the beds and groups enumerated above.

1. *The Coffee Sand.*—This, the oldest Cretaceous group seen at the surface in Tennessee, overlaps the western bevelled edge of the Paleozoic rocks. It is the northern extension of the *Tom-*

[1] The section is made along the line of the Memphis and Charleston R. R. from the Alabama line, through the northeastern corner of Mississippi and the southern part of West Tennessee, to Memphis. Its base-line represents the level of the sea, above which the highest points of the section are about 600 feet. The length of the section is 120 miles.

bigbee sand of Hilgard, which most likely ought to be included in his *Eutaw Group.* Its outcrop occupies a belt of territory varying from about two to eight miles in width, and running more than half way through the State.[4] (See 1, 1, on the map.)

As before stated, the Tennessee, in the southern part of the State, strikes this group. The river here washes the sand, along its western bank, for eighteen or twenty miles and presents us, at intervals, with several bluffs that exhibit interesting sections. The bluffs are much alike; they vary from 80 to 100 feet in height, and are all capped with a layer of gravel belonging to the gravel bed described. The principal ones, (indicated on the map by short heavy lines,) are the *Coffee Bluff,* sometimes strangely called "*Chalk Bluff,*" at *Coffee Landing,* (C. on the map,) that at *Crump's Landing,* and the one at *Pittsburg Landing,* (P. on the map). The first, which gives name to the bed under consideration, is nearly two miles long. One of its sections will be given below.

This group consists mostly of stratified sands usually containing scales of mica. Thin leaves of dark clay are often interstratified with the sand, the clay leaves occasionally predominating. Sometimes beds of dark laminated or slaty clay of considerable thickness—from one to twenty feet or more—are met with in the series. It very generally contains woody fragments and leaves converted more or less into lignite. Silicified trunks of trees are not uncommon. The maximum thickness of the series in Tennessee is not known; it is probably not far from 200 feet.

A section of the bluff at Coffee may be taken as a type of the materials and stratification of this group.

4. *On top;* gravel and ferruginous conglomerate.
3. *Sands,* with thin laminæ of slaty clay; much like No. 1 below. 10 feet.
2. *Slaty clay,* with but little sand; contains fragments of wood and leaves. 20 feet.
1. *Grey and yellow sands,* interstratified with numerous thin laminæ and some thicker layers of slaty clay; strata of sand occasionally from three to six feet without clay. Leaves, in fragments, and pieces of lignitic wood abundant. Projecting from the mass are the ends of two large trunks, their bark converted into lignite and their wood silicified.

   Contains pyrites and yields proto-salts of iron and ferruginous waters.

   Extending to the water's edge. - - - 65 feet.

[4] There is some doubt in regard to the northern limits of this and the succeeding group, (No. 2,) a doubt expressed upon the map by the broken lines bounding the latter. The limits of both are satisfactorily known as far as the lines continue unbroken, but beyond this they are not easily determined and require more examination. The outline given is probably not far from the correct one.

In low sheltered places the sands in the exposures of this group are generally dark grey and contain pyrites. In exposed situations, however, as in old washes or near the surface, their contents become peroxydized, their lignitic matter is removed, (consumed,) and the sands assume brighter colors, becoming white, yellow, red or orange, as the case may be.

Although fragments of leaves are abundant at some localities, yet it is difficult to obtain good specimens. None that I know of have been described. Within the limits of Tennessee I have not found any animal remains in this group. Along the Memphis and Charleston railroad, in Mississippi, I have seen many imperfect casts of shells in its southern equivalent, the *Tombigbee sand.* One of these was forwarded, with other Cretaceous fossils, to Mr. Wm. M. Gabb, of Philadelphia, who described it as *Volutilithes Saffordi*, giving "Tennessee" by mistake as the locality. (*Jour. Acad. Nat. Sci.*, [2], iv, 299.) The specimen was obtained from a cut about three miles and a half west of Burnsville.

2. *The Green Sand, or the shell-bed.*—At many points along its eastern edge this bed is seen resting upon the *Coffee sand.* Its mass consists generally of fine quartzose sand mixed with clay, forming a clayey sand, which is more or less calcareous. It contains *green grains* throughout, though not abundantly, and fine scales of mica. Owing to the clay present and a certain degree of induration, the mass is generally firm enough to form the walls of the "bored wells," tubing being dispensed with.* When dry, the material of the formation has a greenish gray color which becomes much darker when wet. It has much uniformity in character. That of different layers, however, differs to some extent in hardness, and in the proportional amount of green grains. Some of the harder layers are called "rocks" by the well-borers. There is such a layer very generally at the bottom of the series.

Below the soil, for ten or twenty feet from the surface, the Green sand is usually converted by atmospheric agencies into a greyish or dirty-buff tenacious material locally called "*joint clay,*" from its tendency to cleave, when losing moisture, in irregular block-like masses.

It abounds in shells. *Exogyra costata*, *Gryphæa vesicularis*, *Ostrea larva* and *Anomiæ*, are found at nearly all exposures. At numerous points, whitish clayey or marly "bald places," or "glades," nearly or quite destitute of soil and vegetation, are

* To obtain good water in the region of the Green sand it is often necessary to bore through the formation to the *Coffee sand.* Upon reaching this, drinkable water rises often to within a few feet of the surface, depending much however as to this upon the elevation of the mouth of the well. Many such wells have been bored in Tennessee.

met with, strewed over which, individuals of the species mentioned, and of others, are abundant, the large shells being very conspicuous. This formation is preëminently the *shell-bed* of the Post-paleozoic beds of West Tennessee. A list of species collected is given below. It also contains wood and leaves, but not as abundantly as the Coffee sand.

This bed is the northern extension of the *Rotten* limestone of Mississippi and Alabama. Its outcrop in Tennessee occupies a belt of the surface averaging about eight miles in width for at least half way through the State. (2, 2, map and section.) Further north it soon becomes inconspicuous. Its limits in this direction have not been satisfactorily made out. The broken lines mark its probable extension and termination. Its thickness is known from data supplied by the well-borers. Along the western margin of its outcrop it varies from 200 to 350 feet, the maximum being in the southern part of the State.

The list below contains the species collected by myself from this bed. These, together with the species collected from the succeeding group, were submitted to the examination of Messrs. Conrad and Gabb. The new forms were described by them in the *Jour. Acad. Nat. Sci.*, vol. iv, 2d series. In their descriptions some are referred to wrong localities. The principal and correct localities are indicated upon the map by small crosses, and will be designated in the list by letters. They are as follows:

(*a*.) The first, at the very bottom of the bed, in a cut of the Memphis and Charleston R. R. about 2½ miles east of Corinth, (C.) Mississippi.

(*b*.) The "Bald Hills," 14 or 15 miles north of *a*, in Tennessee, and 8 miles northwest of Monterey, in McNairy county.

(*c*.) A bank about 2½ miles east of Purdy, (Pu.) Tenn., and very near the top of the bed.

(*d*.) A cut in the Memphis and Charleston Railroad very near the point where the railroad crosses the Mississippi and Tennessee line.

1.	*Platytrochus speciosus*, Gabb and Horn, - - - -	*d*.
2.	*Corbula crassiplica*, Gabb, - - - - -	*d*.
3.	*Crassatella vadosa*, Mort., (Syn. *C. Ripleyana*, Con.,) -	*a*, *c*.
4.	*Astarte crinulirata*, Con., - - - -	*d*.
5.	*Venilia Conradi*, Mort., - - - - - -	*a*, *c*.
6.	*Cardium abruptum*, Gabb, - - - -	*c*.
7.	*Cardium*, n. sp., casts. ("Common in New Jersey.") -	*a*, *c*.
8.	*Trigonia thoracica*, Mort., - - - -	*a*, *c*.
9.	*Arca Saffordi*, Gabb, - - - - - -	*d*.
10.	*Nucula distorta*, Gabb, - - - - - -	*d*.
11.	*Cucullæa Tippana*, Con., - - - -	*c*.
12.	*Ctenoides* (*Lima*) *pelagica*, Mort., - - -	*a*.
13.	*C. reticulata*, Lyell and Forbes, - - - -	*a*.
14.	*Pecten virgatus*, Nilsson, - - - - - -	*a*.
15.	*Neithea occidentalis*, Con., - - - - -	*a*, *b*, *c*.
	(Syn. *P. quadricostata*, Rœmer, and perhaps *quinquecostata* of Mort.)	

16.	*Ostrea Larva*, Lam., (Syn. *O. falcata*, Mort., not Sow.,) -	*a, b, c, d.*
17.	*O. plumosa*, Mort., - - - - - -	*a, b.*
18.	*O. tecticosta*, Gabb, - - - - - -	*a, b, c, d.*
	(I think this must be *O. crenulata*, Tuomey.)	
19.	*Exogyra costata*, Say, - - - - - -	*a, b, c, d.*
20.	*Gryphæa vesicularis*, Lam., - - - - -	*a, b, c.*
	(Syn. *O. convexa*, Say, and *G. mutabilis*, Mort.)	
21.	*G. Vomer*, Mort., - - - - - -	*a, b.*
22.	*Anomia tellinoides*, Mort., - - - - -	*a, b.*
23.	*A. Argentaria*, Mort., - - - - - -	*a, b, c, d.*
24.	*Placunanomia Saffordi*, Con., - - - - -	*a, b, c, d.*

(Syn. *P. lineata*, Con. *P. lineata* can be connected with *P. Saffordi* by intermediate forms. The species is an abundant and variable one. Its individuals are often much larger than those figured. Figure 21, pl. 46, (*Jour. Acad.*, vol. iv.) shows the appearance of the tooth after the *enamel*, that coats the inside of the valves, has been removed. Since the species was described, a few perfect valves have been found. The tooth is a prominent nearly rhombic boss, the inner angle longer than the one behind and longitudinally striated. One muscular impression nearly central; another nearer the tooth from which the ossified plug appears to start.)

25.	*Scalaria Sillimani*, Mort., - - - - -	*a.*
26.	*Natica rectilabrum*, Con., - - - - -	*c.*
27.	*Volutilithes Texana*, Con., - - - - -	*a.*
28.	*Rapa* (*Pyrula*) *Richardsonii?* Tuomey, - - -	*a.*
29.	*R. trochiformis*, Tuomey, - - - - -	*a.*
30.	*Anchura abrupta*, Con., - - - - -	*c.*
31.	*Baculites compressus*, Say, - - - - -	*a, c.*
32.	*Enchodus ferox*, Leidy, - - - - - -	*b.*
33.	*Sphyræna*, sp.? - - - - - -	*a, b.*
34.	*Ischyrhiza mira*, - - - - - -	*b.*

Besides these, I have in my collection from this bed uncertain species of *Teredo*, *Serpula*, *Rostellaria*, *Fusus*, *Turritella* and *Delphinula*.

3. *Ripley Group.*—This is a provisional series, and is mostly based upon observations made along and in the vicinity of the Memphis and Charleston Railroad. It is only in this region that determinable species have been found, although search has been made elsewhere for them. Its northern extension has been inferred from the general bearings and relations of its strata and of those of the adjacent groups.

Its outcrop occupies a belt of the surface, (3, 3, on the map,) extending through the State and being, along the railroad, about fifteen miles wide, but having a less average width. This belt is in general rough and hilly. The high ridges dividing the waters of the Tennessee and Mississippi rivers lie mostly within its area.

The group must be of considerable thickness, not less than 400 or 500 feet. It is mostly made up of stratified sands. Occasionally an interstratified bed of dark slaty clay, ten to thirty feet thick, is met with, but more frequently a sandy bed laminated with clayey leaves. In its lithological character, the group is much like the *Coffee sand.* Its sandy mass, as seen at the surface, is very generally yellow, brown or orange, its contents being peroxydized; occasionally, however, in partially protected or in fresh exposures, its material is dark colored, abounding more or less in fragmentary lignitic matter.

The outcrop of the group very commonly presents layers or masses of ferruginous sandstone locally indurated by oxyd of iron. This sandstone often occurs in plates, scrolls, tubes and other curious shapes. At some points, especially upon high knobs and ridges, it is found in heavy massive blocks from two or three to fifteen feet in thickness. The occurrence of such sandstone is, however, common to all the sand-formations of West Tennessee. In this group it appears to be especially abundant.

In the vicinity of the Memphis and Charleston Railroad, in Hardeman County, there are in the upper part of the series two local beds interesting on account of the fossils they contain. The first is a bed of buff grey impure *limestone* from two to six feet thick. It is found on both sides of the railroad near Muddy Creek.[6] It abounds in two or three species of *Turritella*, (*T. Saffordi*, and *pumila of* Gabb,) *Ostrea Vomer*, Mort., claws of a *Callianassa?* (for which I propose the name *C. Gwyni*,[7]) and other species. The position of the *limestone* is indicated on the map by the short, heavy lines near Muddy Creek. It is doubtless the "Turritella" and "Bored" limestone of Hilgard's sections Nos. 12, 13, and 14; pp. 86–88.

The second is a bed of clayey sand with *green grains.* This has been seen west of the limestone at two exposures; one in a small cut on the railroad, about two miles east of Middleton, the other about two miles south or southeast of Middleton, on a branch of Cypress Creek, (of Hardeman,) and near the "old stage road." Each point is indicated upon the map by a small cross.

The following is a list of species from the two beds, to which it will be seen quite a number of the forms are common. Most of them are described in the *Jour. Acad. Nat. Sci. of Phila.*. vol. iv, 2d series. The localities are (a.) *limestone;* (b.) *sand-bed.*

1. *Corbula subcompressa*, Gabb, - - - - - *b.*
2. *Venus Ripleyana*, Gabb, - - - - - *a, b.*

[6] On the map accompanying this article, Muddy Creek is the first stream represented east of "*M*," on the railroad. *M.* is Middleton depot.

[7] Dedicated to Prof. H. A. Gwyn, of Saulsbury, Tennessee.

3. *Crassatella pteropsis*, Gabb, - - - - - *a, b.*
(Conrad had previously given this name to a species of *Crassatella*; *Jour. Acad.*, iv, 279. I therefore propose *C. Gabbi* for it.)
4. *C. Monmouthensis?* Gabb, - - - - - *b.*
5. *Cardita subquadrata?* Gabb, - - - - - *b.*
6. *Leda protexta*, Gabb, - - - - - - *b.*
7. *Modiola Saffordi*, Gabb, - - - - - - *a, b.*
8. *Ostrea denticulifera*, Con., - - - - - *a, b.*
9. *O. crenulimarginata*, Gabb, - - - - - *b.*
(If No. 8 is referred to the proper species, then *O. crenulimarginata*, Gabb, is, I think, its lower or larger valve.)
10. *Gryphæa Vomer*, Mort., - - - - - - *a.*
11. *Turritella Tennesseensis*, Gabb, - - - - *b.*
12. *T. Saffordi*, Gabb, - - - - - - *a, b.*
13. *T. Hardemanensis*, Gabb, - - - - - *b.*
14. *T. pumila*, Gabb, - - - - - - *a, b.*
15. *Natica rectilabrum*, Con., - - - - - *b.*
16. *Fasciolaria Saffordi*, Gabb, - - - - - *b.*
17. *Neptunea impressa*, Gabb, - - - - - *b.*
18. *Callianassa? Gwyni*, Safford, - - - - *a, b.*
19. *Lamna gracilis?* Ag., - - - - - - *b.*
20. *Crocodilus?* (Tooth.) - - - - - - *b.*

It will be seen that but two species of those given, *Gryphæa Vomer* and *Natica rectilabrum*, are common to this group and the Green sand. Localities in Mississippi, however, furnish series of fossils which unite the groups more intimately. It will be found perhaps that the two form paleontologically but one formation.

The group also contains wood and leaves. The leaves are generally found in an imperfect condition and have received but little attention. As the age of the beds containing them are known, their study would be very interesting in connection with that of the leaves of the formations further west which are of uncertain age.

4. *The Porter's Creek Group.*—I have heretofore included this series in the *Orange sand.* It may be well however to keep it separate until its age is more satisfactorily ascertained. There is no marked distinction between this and the adjacent groups, except that it contains proportionally much more laminated or slaty clay. The clay has the usual characters, contains mica-scales, is dark when wet and whitish grey when dry. The thickness of the series is perhaps 200 or 300 feet. In this are usually several beds of slaty clay from five to fifty feet in thickness. In Hardeman county, on Porter's Creek,* is a heavy bed said to be 100 feet thick. I have seen as much as 50 or 60 feet of it exposed.

* The first creek on the map, west of "M," (Middleton,) on the M. & C. R. R.

Along the Memphis and Charleston Railroad, the belt of surface occupied by the group is about eight miles wide. It becomes narrower as we follow it northward. (4, 4, on the map.) The belt appears to be the northern extension of Hilgard's "Flatwoods" region, the group itself forming the lower part of his "Northern Lignitic." I have met with hard layers, "rocks," in this series containing shells, but as yet have found no determinable ones. In several of the cuts along the M. & C. Railroad, specimens of leaves are found in the clays and sometimes in thin local sandstones. The leaves in my collection from this group, which are not many, have not been examined. One is much like *Quercus Saffordii*, Lsqx., of the succeeding group, and may be that species; the others are unknown to me.

5. *The Orange Sand, or LaGrange Group.*—The outcrop of this group forms more than a third of the entire surface of West Tennessee. It occupies a belt about 40 miles wide, which runs in a north-northeasterly direction through nearly the central portion of this division of the State. (See map and section 5, 5.) As seen in bluffs, railroad cuts, gullies, and in nearly all exposures, it is generally a great stratified mass of yellow, orange, red, or brown and white sands, presenting occasionally an interstratified bed of white, gray, or variegated clay. The sand-beds are usually more or less argillaceous; sometimes but little or not at all so. Like the Ripley Group, it contains patches, plates, and thin layers of ferruginous, sometimes argillaceous, sandstone, and, as in that group, presents locally massive blocks of sandstone on high points. At La Grange a fine section of the group, more than a hundred feet in thickness, is exposed.

In deep wells dark beds of sand with occasionally one of clay are met with. These often contain vegetable matter. Now and then the trunk of a tree is encountered, much to the annoyance of well diggers. I have seen but one bed of lignite in the group, and that a limited one near its southeastern margin.

It is difficult to estimate the thickness of this group. It doubtless dips, though at a small angle, to the west. Its thickness may be assumed to be about 600 feet.

At the bottom of a railroad cut three miles south of Somerville, (S. on the map,) in Fayette county, I collected several years ago, from a thin sandstone in place, a series of fossil leaves beautifully preserved. The locality is marked on the map by a small cross. These were described by Mr. Leo Lesquereux in 1859,[*] and have since been lithographed for my State Report, the publication of which has been interrupted by the present un-

[*] This Journal, [2], xxvii. 363.

happy condition of the country. The following is a list of the species as revised by Mr. Lesquereux:

1. *Quercus myrtifolia ?* Willd.
2. *Prunus Caroliniana*, Michx.
3. *Laurus Caroliniensis ?* Michx.
4. *Fagus ferruginea*, Michx. (Fruit.)
5. *Quercus crassinervis*, Ung.
6. *Quercus Saffordii*, Lsqx.
7. *Andromeda vaccinifoliæ affinis.*
8. *Andromeda dubia*, Lsqx.
9. *Elæagnus inæqualis*, Lsqx.
10. *Sapotacites Americanus*, Lsqx.
11. *Salix ? densinervis*, Lsqx.

The first four are recent; the others are new or unknown. In a letter to me of Feb. 1861, Mr. Lesquereux expresses the opinion that they are of *Miocene*, and most likely of *Upper Miocene*, age. In deference to my excellent friend's opinion, I shall regard the group as Miocene until more light can be thrown upon the question.[10] Had it not been for the present condition of the country more ample material would have been placed in his hands for study.

I have not been able to find even the cast of a shell in this series. The discovery of a few known species, if such exist, is a desideratum.

6. *The Bluff Lignite.*—This is a provisional group, and consists, especially in the middle and southern parts of the State, of a series of stratified sands with more or less sandy slaty clay, characterized by the presence of well-marked beds of *lignite*.[11] I have recently included it in the Orange sand. It will be best, however, to keep it separate until the questions of age are definitely settled. The upper part of the series is generally well exposed below the gravel of the Mississippi bluffs. At Memphis, however, it scarcely appears above low water. About one hundred feet of the series has been seen below the gravel. In this thickness it contains from one to three beds of lignite, which are from half a foot to four feet in thickness.

The group has no *marked* eastern outcrop, and *may* thin out

[10] I must confess that I cannot rid myself of the impression that this group is older—at least *Eocene*. I do not know that I can assign a good reason for this *impression*. I have seen, however, imperfect specimens of leaves in older beds, even in known *Cretaceous clays*, much like some of those of this group, although I could not say they were absolutely identical, on account of their unsatisfactory condition. I see too that Hilgard is inclined to place his "Northern Lignitic," which includes my Porter's Creek and Orange Sand groups, at the very bottom of the Eocene. See his Report, page 108 and on.

In reference to the leaves above, it will be remarked that two of the recent species are given with a query; some doubt, too, is expressed (this Journal, *loc. cit.*), with reference to the identity of the nut of *F. ferruginea*. I am aware that Mr. L's opinion is strengthened by the character of leaves from Mississippi. But after all, the study special and comparative of the floras of the Tertiary and Cretaceous beds in Mississippi and Tennessee, and, may I not say, in America, has been but just commenced, and it may yet be premature to form decided opinions based upon leaves.

[11] In the northern part of the State, its upper portion is frequently more or less indurated, presenting layers of soft sandstone; and here too the lignite is not as well seen.

n an easterly direction beneath the gravel; at least, the beds of ignite, by which it is characterized, do not appear to extend very far east from the range of the bluffs. (See section 6.) In my "Reconnoissance," p. 102, may be found a section illustrating the *Bluff formations.* Below, I give another taken on the Mississippi, at Randolph, Tipton county, the river being four or five feet above low-water mark.

8. *Bluff Loam*, 68 *feet.*
Fine siliceous earthy matter of a light ashen or a light buff color, containing land-shells.

7. *Bluff Gravel*, 24 *feet.*
Chert pebbles, and coarse yellow and orange sand, with a bed six feet thick of variegated plastic clay beneath.

6. *Bluff Lignite*, 90 *feet.*
A mass of dark grayish laminated micaceous sand with lignitic woody fragments, leaves, &c. Laminæ of sand alternate with other laminæ containing more or less clay. Interstratified with this are two beds of lignite; the upper one six feet from the top and from six inches to two feet thick; the other 12 feet lower and about eight inches thick. Some thin laminæ of lignite occur below this bed. This portion in all, - - - - - 48 ft.
A portion not exposed in place where the section was taken, but seen in part at another point; consists of laminated sand like that above. Down to the water's edge. - - - 42 ft.

Leaves from the Bluff lignite, at least from the portion in Tennessee, have not, so far as I know, been examined. The series may be synchronous with that at the *Chalk Banks*, near Columbus, Ky., some of the leaves of which have been described by Mr. Lesquereux. (This *Journal*, [2], xxvii, 364.)

7. *The Bluff Gravel.*—This bed varies in thickness from ten to fifty feet. It consists generally of coarse yellow and orange sands, with everywhere more or less coarse gravel, and has usually a layer of white or variegated clay at its base. The gravel is generally the most conspicuous portion. This is sometimes cemented by oxyd of iron (occasionally by calcareous matter) into great blocks of coarse conglomerate. It consists of water-worn pebbles, from the size of a man's fist down to that of a pigeon's egg. The pebbles have been derived mostly from Carboniferous chert.

This bed is remarkable for its extent in a general direction parallel with the river. It is seen along the face of the *Mississippi bluff*,[13] from the Mississippi state line to Kentucky, and both ways much beyond these limits.

[13] I have given this general name to the line of bluffs that all along overlook either the river or its bottom, mostly the latter. The bluffs are the western escarpments of the highlands back of the bottom. This escarpment is cut by the narrow valleys of the rivers flowing from the east, but for general purposes may be regarded as continuous.

Its eastern outcrop is not well marked. It appears to extend from 15 to 20 miles eastward from a straight line drawn through the most westerly parts of the bluff. The bed is represented on the map and in the section by a dotted or broken line. (7, 7.) It will be seen that the narrow river-valleys of West Tennessee cut this and the Bluff loam into sections.

8. *The Bluff Loam.*—This, the topmost of the bluff formations, is generally a mass of fine siliceous loam, somewhat calcareous, and usually of a light ashen yellowish or buff color, but sometimes lacking the yellow tinge. It is indistinctly stratified; contains land and fresh-water shells, and frequently oddly shaped calcareous concretions. It has in Tennessee a maximum thickness of about 100 feet, ranging generally, however, from 30 to 80. In the bluff at Memphis, it is from 40 to 60 feet thick, and presents in its lower part, along a well-marked horizon and in a vertical position, earthy ferruginous casts or moulds of what may have been the long tapering tap-roots of some tree.

The loam rests directly upon the Bluff gravel, and its range and extent are shown upon the map by the spaces included within the broken lines representing the outcrops of the gravel. Its eastern limit, like the eastern outcrop of the underlying bed, is with difficulty defined; both are alike given approximately.

The following species of shells have been collected from this formation;

1. *Helix appressa*, Memphis.	6. *Planorbis bicarinatus*, Memphis.
2. *H. hirsuta*, "	7. *Cyclas*, sp.? "
3. *H. monodon*, "	8. *Amnicola lapidaria*, "
4. *H. solitaria*, Dyer county.	9. *Lymnea*, sp.? "
5. *H. profunda*, Hickman, Ky.	10. *Succinea*, sp.? "

Dr. Wyman has published a "Notice of Fossil Bones from the neighborhood of Memphis," which he states are representatives of the genera *Mastodon*, *Megalonyx*, *Castor*, and *Castoroides*, and that they are "from, as is supposed, the diluvium of the Mississippi."[13] The geological position as given here is very indefinite. I think it, however, more than probable that the bones come from the *Bluff loam.* It is the principal formation in the vicinity of Memphis. The Bluff gravel, which here, by the way, contains much sand, is found mostly in the beds of the streams below high-water mark.

9. *The Bottom Alluvium.*—This consists of the usual beds of sand, clay, gravel and vegetable matter of the Mississippi bottom. I do not propose to dwell upon it here. As a whole, its extent in Tennessee can be seen upon the map. (9,9.)

[13] This Journal, [2], x, 56.

ART. XXXIV.—*On the Influence of Ozone and some other Chemical Agents on Germination and Vegetation;* by M. CAREY LEA, Philadelphia.

AT no time has the subject of the influences of chemical agents on plants received so much intelligent attention as at present, and the labors of Boussingault, Knop, Stohmann, Ville, Sachs, and many others, are daily adding to our stock of knowledge and developing new and interesting facts. The studies of these chemists have, however, been directed almost entirely to the effects of the absence or presence in greater or less proportion in the soil of those bases and acids which are there commonly found. With respect to other agencies, little has been done since the valuable investigations of Turner and Christison, made more than thirty years ago, in which they examined the effects of chlorhydric and nitrous acid gases, chlorine, sulphuretted hydrogen, cyanogen and some other gases. Göppert about the same time published some investigations upon the influence of cyanhydric acid. The effect of all these substances was very much what might have been anticipated from their tendency to attack organic tissues.

The examinations which I propose here to describe have been made in a somewhat different direction. The most curious result obtained appears to me to be that relating to the effect of a highly ozonized atmosphere upon the roots of plants. I have also found that organic substances not in the least corrosive, and even entirely neutral, may exercise a powerfully poisonous influence upon vegetation, when disseminated in the atmosphere surrounding it.

(1.) *Influence of Ozone.*

The ozone used in the following experiments was generated by the action of sulphuric acid upon chameleon mineral. Two or three grains of chameleon mineral were placed in a small capsule and moistened with oil of vitriol. This, when placed by itself, or with a vessel of water under a bell-glass of about 3 litres capacity, was found to maintain a highly ozonized atmosphere for five or six days or even longer. But as the presence of vegetation would tend to destroy the ozone rapidly, it was considered expedient to renew the generating mixture every two or three days. In all cases the capsule was placed aside for half an hour or more to allow the red vapors to be thoroughly dissipated before introducing it beneath the bell glass.

Two sets of experiments were made: in the first, the water with which the seeds came in contact was made to contain those solid substances which are most essential to vegetation. In the

second, very pure river water was used. For the first, phosphate of soda, silicate of potash, sulphate of magnesia, nitrate of lime and sesquichlorid of iron were added to water in a proportion such as to be equivalent to three-tenths of one per cent of solid matter. In order to afford a just term of comparison, two vessels every way similar were filled with this prepared water, were covered with gauze so that the gauze should rest on the surface of the water, and were placed under bell-glasses resting on glass plates. Wheat and maize grains were placed on the gauze, and beneath one bell-glass was introduced the ozone-generating mixture.

2d day.—Germination appeared to be more advanced in the vessel containing the ozone. Seeds, however, of like origin, and exposed to the same influences, germinate so irregularly that much importance is not to be ascribed to this.

3d day.—The seeds in ordinary air had overtaken the others. They were already covered with mould, of which no sign appeared on those exposed to ozone.

4th day.—Mouldiness much increased in the one, still none in the other. The rootlets of the plants exposed to ozone begin to exhibit remarkable effects, extending themselves upward instead of downward, and becoming pinkish at the extremities.

5th day.—Ozone plants much behind.

8th day.—The disposition of the roots of the plants exposed to ozone to grow upward still continues. Of the wheat plants, fully one-half the rootlets have shot directly into the air. The only maize plant which has as yet germinated has sent up a healthy plumula over one inch in length; its three rootlets are all directed upward and away from the water. Nothing in the least similar has taken place in any of the seeds not exposed to the influence of ozone.

12th day.—The experiment was terminated. The average height of the wheat plants not exposed to the ozone was 10 inches; of those exposed, 4 inches. The effect of the ozone in checking the growth of the roots was very remarkable, especially with the wheat plants. In those not exposed to ozone, the roots attained a length equal to about one-fourth the height of the stem. In those exposed to it, the roots after starting almost immediately ceased to grow; the strongest plant attained a height of six inches, and developed six rootlets, averaging only three-sixteenths of an inch in length, while those not exposed to ozone had many roots exceeding two and a-half inches. As a whole, the roots produced by the plants under the influence of ozone did not exceed one-tenth of those produced in its absence from an equal number of healthy seeds. One curious result of the almost total absence of roots was that the wheat plants were scarcely able to sustain themselves in a vertical position: the

greater part of them fell over on one side. The flatness of the grains of maize afforded their plants a better support.

The influence of ozone over the production of mould was very striking. When seeds were placed in contact with water and with the air under a bell-glass in which a vessel of water stands, which air is of course saturated with moisture, mould began immediately to form, and increased until the surface of the gauze which rested on the water was completely covered. Nothing of the sort was visible in the bell-glass containing an ozonized atmosphere.

In order the better to observe the influence of ozone upon the mould, the vessel which contained it was transferred to the bell-glass of which the atmosphere was ozonized. In the course of a few hours, the greater part of the mould fell back upon the gauze as a yellowish powder, while two healthy young maize plants appeared unaffected, and continued their development. With a longer exposure, they would of course also have suffered, but their stronger vitality enabled them to resist longer. It was also remarked that the extremities of the leaves of some wheat plants, growing in the same vessel, became yellow. But those wheat plants which had germinated in the ozone atmosphere, although much smaller, were perfectly healthy, and the leaves showed no disposition to die at the ends.

Pasteur has lately shown that the putrefaction and oxydation of organic bodies is effected to a very large extent by the intervention of the lowest order of vegetable organisms. That in some cases where the germs of these bodies have been carefully excluded, milk for example has been kept in the presence of atmospheric air for a year without alteration; and that when sawdust was enclosed in a flask for a month, the germs having been similarly excluded, the air still contained 16 per cent of uncombined oxygen.[1] It therefore appears that ozone, while a highly oxydizing agent, may in some cases check putrefaction and oxydation by destroying the intermediate agencies, through which these operations are effected; a fact not without interest in connection with the alleged influence of ozone on epidemics.

The experiments just described were carefully repeated with the substitution of very pure river water, instead of that containing the salts already mentioned. The results obtained were precisely the same. These trials afforded a double set of parallel experiments, similar sets of seeds having been exposed to the action of saline solutions, and to that of river water nearly pure, in both cases with and without the influence of ozone. Clearly, therefore, to nothing but ozone could be ascribed the inverted tendency of the roots, as this always followed its presence, and never appeared in its absence.

[1] See *Rép. de Chimie Pure*, Sep. 1863, p. 479.

(2.) *Carbonic Acid.*

Experiments were made to ascertain the effect of a complete removal of carbonic acid from the atmosphere surrounding plants. The seeds were placed on gauze strained over a vessel of water, which was set in a dish containing concentrated solution of caustic soda, and the whole was covered with a bell-glass. A similar arrangement was made, exclusive of the caustic alkali, to afford a term of comparison.

No appreciable difference could be observed. It is probable that seedlings, within the height which they can attain under an ordinary bell-glass, still derive a sufficient supply of carbon from the seed. Be this as it may, the removal of carbonic acid from the atmosphere surrounding them did not interfere with their growth.

Experiments made with seeds placed in an atmosphere of carbonic acid accorded with results obtained by other observers, as to total prevention of germination under circumstances otherwise favorable. The seeds, however, were found to be not in any way injured, and germinated freely on exposure to the atmosphere.

It seems probable that in those cases in which germination has been observed to take place in an atmosphere of carbonic acid gas,[a] the exclusion of atmospheric air has not been sufficiently well maintained.

(3.) *Simple and Compound Ethers.*

Seeds were placed on gauze under a bell-glass, as before, and an open narrow-mouthed vial containing a little ether was introduced. Germination was entirely prevented.

Nitrate of methyl produced a similar effect.

(4.) *Organic Acids in Solution.*

Two organic acids were selected for experiment: oxalic acid as being reducing, non-nitrogenous and sharp; picric acid as oxydating, nitrogenous and bitter. Both were dissolved in water in the proportion of three-tenths of one per cent. Germination was found to be entirely prevented, by the presence of even so small a quantity of these substances. To ascertain if this effect resulted from the acid reaction of the solutions, other solutions were made of oxalate and picrate of ammonia, so proportioned that each solution should contain precisely the same proportion of acid as before, viz.: three-tenths of one per cent. In the neutral solution of oxalate, a slow germination followed; in that of picrate, none whatever.

[a] Lindley, *Int. to Botany*, p. 359.

ART. XXXV.—*Remarks on the Distillation of Substances of different Volatilities;* by M. CAREY LEA.

SOME experiments which have been recently published by M. Berthelot recall to me a similar and remarkable case which attracted my attention several years ago.

M. Berthelot distilled 92 parts of alcohol and 8 of water, and found that the distillate at the beginning, middle, and end of the operation contained equal quantities of water and of alcohol.

He distilled also a mixture containing a large quantity of sulphid of carbon and a small quantity of alcohol, and found that the least volatile body, the alcohol, passed over with the first portions of the distillate, so that toward the end of the operation, the retort contained sulphid of carbon almost pure.

To these facts, which tend to cast the greatest doubt on all the results obtained by the laborious process of fractional distillation, I now add the following.

When a mixture containing the chlorids of ethylamin, diethylamin, and triethylamin is distilled with caustic alkali, we should, according to received ideas, expect to find the ethylamin, which is a gas at ordinary temperatures, distil over first. Triethylamin, which is at ordinary temperatures and pressures a liquid, separates as such when a strong solution of its chlorid is treated with caustic alkali, and floating on the surface, as I have before pointed out, we would naturally expect to find it principally in the later stages of the distillation. The contrary is however the case, when the less substituted ammonias predominate in quantity. Almost the whole of the triethylamin passes over in the first portions of the distillate, and subsequent ones, though rich in ethylamin and diethylamin, scarcely contain a trace of triethylamin.

ART. XXXVI.—*The original accounts of the displays in former times of the November Star-Shower; together with a determination of the length of its cycle, its annual period, and the probable orbit of the group of bodies around the sun;* by H. A. NEWTON.

IN the following pages I propose to give, so far as I can, the original accounts of those displays of shooting stars which may be considered the predecessors of the great exhibition on the morning of Nov. 13th, 1833. These accounts afford data for the determination of the length of the annual period, and the thirty-three year cycle. They furnish additional arguments (if such arguments are needed) for the theory that the shooting stars

are small bodies moving originally each in its own orbit, until they come into the earth's atmosphere, where they burn for an instant and are dissipated into smoke or dust. They show that the time during which the swarm of bodies furnishing the November meteors revolves about the sun must be limited to one of five accurately determined periods, one of which is more probable than the others. They will serve to direct future observation, and perhaps verify or correct such hypotheses as have been, or may be presented.

Several catalogues of ancient star-showers have been published.[1] Nearly all the accounts given below are cited in full or in part in these catalogues. I have copied so far as I could from the original writers. A few citations not heretofore given are added. Translations are given of many of the passages, for some of which, and for other valuable aid, I am indebted to the kindness of friends.

I. A. D. 902.

Near the middle of October, A. D. 902, occurred one of the most remarkable star-showers on record. The following accounts, although the recorded dates differ, refer evidently to the same phenomenon.

1. "En la luna Dylcada de este mismo año murió el rey Ibrahim ben Ahmed, y aquella noche se vieron como lanzadas infinitas estrellas que se esparcieron como lluvia á derecha é izquierda, y se llamó este año el de las Estrellas." Conde, *Historia de la Dominacion de los Árabes en España.* 8°, Paris, 1840, p. 198. *This Journal*, xl, 353. *First quoted by Von Hammer.*

In the month Dhu-l-Ka'dah of this same year (289 A. H.) died king Ibrâhîm bin Ahmad, and that night there were seen, as it were lances, an infinite number of stars, which scattered themselves like rain to right and left, and that year was called the year of the stars.

2. "Anno Dominicae Incarnationis 902 urbs Tauromenis a Sarracenis capta est. Eodem anno in nocte visi sunt igniculi in modum stellarum per äera discurrentes: qua nocte Rex Africae residens super Cosentiam Calabriae civitatem, Dei judicio, mortuus est." *Chronicon Romualdi II, Archiepisc. Salernitani: Muratori, Rer. Ital. Scr.*, vii, 160. (*This Journal*, xl, 354.) *First quoted by Mr. Herrick.*

3. "Hoc tempore noctis medio visi sunt igniculi in modum stellarum huc illucque per äera discurrere. Tunc Civitas Rhegium a filio Regis Asor capta est. Urbs Taurimenis capta est a Saracenis. Rex vero Africes super Cosentiam residens, nocte quadam Dei judicio mortuus est." *Chronicon Vulturnense: Muratori, Rer. Ital. Scr.*, i, pars 2, p. 415.

In the preceding paragraph the date, A. D. 901 is given.

4. "His itaque patratis, vix dum sex dies effluxerant, cum visu formidabile, dictuque mirabile prodigium, ingentem omnibus timorem incussit. Astra namque toto passim coelo confixa per noctem volare, militumque instar confligentium, alterno visa concurrere illapsu." *Martyrium Sancti Procopii;* scriptore Joanne Diacono Neap.: *Muratori, Rer. Ital. Scr.*, i, pars 2, p. 271.

[1] Mr. Quetelet has published three catalogues, two in the *Mémoires de l'Acad. Roy. de Bruxelles*, and a third in his *Physique du Globe.* Mr. Herrick published one in *this Journal*, xl, 349. Mr. Chasles communicated one to the Academy of Sciences at Paris, published in the *Comptes Rendus*, xii, 499. Mr. A. Perrey added many citations from the chroniclers, *Compt. Rend.*, xiv, 19. Mr. E. Biot presented to the same Academy a *Catalogue Général des Etoiles Filantes et d'autres Météores observés en Chine*, which was published in the tenth volume of the Memoirs of the Academy. There is a large catalogue in Arago's *Astronomie Populaire*, iv, 292-345. It is entirely a compilation from the others.

In the preceding paragraph are related the razing of Castellum Lucullanum from fear of the Saracens, the removal of the citizens to Naples, and the translation of the body of St. Severinus to the monastery that bore his name. The razing of the town occupied five days, and was finished on the 4th day before the Ides of October, that is, Tuesday, Oct. 12th. In a note Cajetanus says,:

"Joannes Diaconus cum Translationem corporis Sancti Severini e Castello Lucullano Neapolim enarrasset, itum dixerat a Pontifice, et Clero ad illud inquirendum 4. Idus Octobris; ut in ejus Basilicam deventum est, post Missarum solemnia, deturbato altari, effossaque humo, integrum adhuc corpus est inventum; cumque per noctem in psalmis, et canticis vigilatum esset, postero die, celebri cum pompa, in urbem Neapolim deportatum est, facta igitur haec translatio 3. Idus, an pridie Idus Octobris? sex fere post dies a Translatione corporis Sancti Severini, idest sub 13. Kal. Novembris, portenta, quae hic narrantur, evenere, multasque post preces et supplicationes, extinctum esse regem nuntiatum est, igitur, ut ex hac narratione erui potest, extremo Octobri sane ille extinctus, summum ineunte Novembri; certum eodem anno 903. quo Tauromenium expugnaverat, et Sanctum Procopium Episcopum interfecerat."

In other places he contends that the year of the capture of Taormina and the invasion of Calabria was A.D. 903. He refers to his notes on the life of St. Elias Ennensis in the *Vitae SS. Siculorum* for the proof. I have not access to this work, but am convinced that the year is A.D. 902. The minuteness and consecution of the Arab chronicles of these political events make it impossible to suppose the year in error.

5. "Anno igitur ab incarnatione Domini nongentissimo secundo indic. 5. 3. Idus Octobris regnantibus Leone et Alexandro augustis residenteque quarto Benedicto Romano pontifice, Parthenopense duce Gregorio et Stephano tercio episcopo, factum est per totum mundum terribile miraculum in celo, a primo gallicantu usque ad solis ortum, vise sunt quasi stelle densissime in modum aste longissime per aera discurrere, contra omnes pene cardines celi, ita ut omnium aspicientium hominum mentes terrerent, eo quod nullius meminit etas nec ulla prodit historia huiusmodi mirabile portentum. Hac etenim tempestate rex Africe cum innumerabili exercitu adveniens, totam Italiam invadere cupiebat, qui cum pervenisset in Siciliam Tauriminensem civitatem optime munitam et in montis vertice positam statim apprehendit, ibique multos christianos, cum ad nequiciam sue fidei eos flectere nequisset, cum Procobio episcopo eiusque clero in una aecclesia recludens, crudeliter igne combussit, transfretansque ad Calabriam, Regium comprehendit. Cum autem eodem conamine obsideret Cosentiam Italiae urbem et apprehendere niteretur, eadem nocte qua praedictum signum stellarum visum est, celesti gladio percussus, repentina morte interiit. Exercitus vero illius metu ac pavore perterritus, ad Africam redire cupiens, pene omnis naufragio consumptus est, sicque Dei omnipotentis misericordia Italia in articulo Martis posita ab eius gladio liberata est. Unde quidam astruere voluerunt, ab illius morte signum esse factum stellarum. Sed quia non solum in Italia sed in toto mundo visum est, magis credendum est euangelii completam esse sententiam dicentis: "Erunt signa in sole et luna et stellis;" neque enim tale signum pro iniqui regis morte in universo orbe Deus ostenderat." *Chronicon Salernitanum: Pertz*, III, p. 549, n.

6. "902. Ostensa sunt hoc anno portenta; stella velud pluvie per maximam noctis partem cadentes; Rhenus et multi Saxonie fluvii, ut testantur navigantes et molendini, naturalem cursum in ipsa nocte, hoc est in 5 Kalend. Octobris, non habuerunt." *Annalista Saxo: Pertz*, vi, 590.

The same account in nearly the same words is found in the *Annales Palidenses: Pertz*, xvi, 60. The year 903 is, however, given as the date.

7. The following account refers, if the date is correct, to Nov. 14th, A. D. 899. But it seems probable that the year should be

changed from A. H. 286 to A. H. 289. The extract was first quoted by Mr. Frähn, *Bull. Sci. de l'Acad. de St. Petersbourg*, vol. iii, p. 310, from *Hist. Sarac.* .... à Georg. Elmacino ... op. ... Th. Erpenii, p. 181.

وفى بسنة ست وثمانين ومايتين حدث فى مصر رجفة يوم الاربعاء لسبع
خلون من ذى القعدة من نصف الليل الى الصباح واضطربت الكواكب
التى يقال لها الشهب اضطرابا شديدا وكانت الشهب تنتقل شرقا وغربا
وشمالا وجنوبا ولم يكن لاحد طاقة ان ينظر الى السماء لاجل ذلك

In the year 286 there happened in Egypt an earthquake, on the Fourth Day [of the week], on the 7th of Dhu-l-Ḳa'dah, lasting from the middle of the night until morning; and so-called flaming stars struck one against another violently, while being borne eastward and westward, northward and southward; and no one could bear to look toward the heavens, on account of this phenomenon.[a]

It is very desirable to determine the day on which this remarkable shower occurred. The historical evidence, however, is quite conflicting. The years A. D. 901 and 903 are mentioned, and the latter contended for, but both are manifest errors. The extract cited above from the *Chronicon Salernitanum* gives the date of the shower as Wednesday, Oct. 13th, A. D. 902. That from the *Annalista Saxo* says it occurred on the 27th of September. The account by *Joannes Diaconus* is probably from an eye-witness, and implies that the shower was during the week following Oct. 12th. Several of the accounts connect it with the death of the cruel Aghlabite king, Ibrâhîm Bin Aḥmad, whom the Christians, and his own subjects also, had such good reason to fear. Absolute identity of the date of the shower with the king's death cannot be affirmed. The terrified and superstitious monks would naturally connect the two events, even if they were several days apart, especially if they heard of the king's death some days after it happened.

Among the Arab annalists, moreover, there is no agreement as to the day of his death. Abu-l-fidâ states that he died of dysentery on the night before Saturday the 19th day of the 11th month, A. H., 289 (*Annales Muslemici* ... J. J. Reiskii, &c. 4°. Hafniae, ii. 289). But the 19th of Dhu-l-Ḳa'dah was Monday instead of Saturday. Jannâbî, according to Mr. Frähn,

[a] The following may refer to the same event. The August shower was then in July. "903. Hoc anno mense Augusto stellae de coelo per noctem visae sunt decidisse." *Annales S. Quintini Veromandensis: Pertz*, xvi, 507.

The *ictu fulguris* of the following statement was doubtless suggested by the shower. "Anno 901 descendit Abraham rex Sarracenorum in Calabriam, et ivit Cosentiam civitatem et percussus est ictu fulguris." *Lupi Protospatae Chronicon: Muratori, Rer. Ital. Scr.*, v, 38.

It is also not improbable that the extract from 'Abd-al-Latîf, quoted by Mr. Frähn (also *this Journal*, xl, 354), refers to the same shower. "I remember that in the year 290 [of the Hijrah, beginning Dec. 4, A.D. 902] burning meteors were seen in Egypt, which scattered themselves through the air and filled the whole expanse. They caused great terror and increased continually."

agrees with Abu-l-Fidâ, while Ibn-al-Khatîb says the death was on the 18th. Nuwairî says it was the night before Saturday the 28th of Dhu-l-Ka'dah, A.H. 289 (*Ms.* 702 *A. fol.* 53 *vers. and* 54 *rect.* of the Bibliothèque Imperiale at Paris, cited by Noel des Vergers, *Histoire de l'Afrique*, &c., p. 144). Again, Mr. Sédillot gives for the date the 12th of Dhu-l-Ka'dah, or the 18th (*Comptes Rendus*, xxix, 746). Ibn-al-Athîr says he died on the 19th (extr. fr. the *Kâmil-at-Tawârikh* of Ibn-al-Athîr, as edited in part by Amari in his *Biblioteca Arabo-Sicula*, p. 242). The 19th of Dhu-l-Ka'dah was the 25th of October, while the 28th was the 3d of November.

Amid this confusion of dates it would not be easy from historical evidence alone to detect the true day of the shower. But when we know that the subsequent displays point back to the morning of Wednesday, the 13th of October, we feel justified in calling that the date. It is expressly given in the *Chronicon Salernitanum*. The six days mentioned by Joannes Diaconus may perhaps be counted from the beginning of the razing of Castellum Lucullanum and not from its close. If the extract from Elmacinus refers, as I suspect it does, to A.H. 289, it implies also that the shower was on the same Wednesday morning.

II. A. D. 931.

"931. Même période (*Tchang-ching*), 2e année, 9e lune, jour *ping-su* (15 Octobre), ..., Après le cinquième coup de tambour, jusqu'au jour, on vit, au milieu et dans les quatre parties du ciel, plus de cent petites étoiles filantes allant en sens divers." E. Biot, *Catalogue Général*, etc., p. 33. This catalogue is from the tenth volume of the *Mem. Roy. Acad. Sci. de Paris.*

A. D. 931. Same period, second year, ninth month, the 23d day of the cycle (Oct. 15th). After the fifth watch until daylight, were seen, above, and in the four quarters of the sky, more than a hundred shooting stars moving in different directions.

In Biot's memoir successive events throughout a night are always related without a break at midnight. Inasmuch as the Chinese do not count the day from sunset to sunset, it is proper to infer that events happening in a morning are reported as happening on the *preceding* day. This may not, however, always be the case. The time referred to in this extract is, I suppose, the morning of Oct. 16th.

III. A. D. 934.

1. "934. Période *Thsing-thaï*, 1re année, 9e lune, jour *sin-tcheou* (14 Octobre).... Le receuil *Sin-ou-taï-sse* dit simplement à cette même date: 'Il y eut beaucoup d'étoiles filantes ensemble.'" E. Biot, *Catal. etc.*, p. 34.

A. D. 934. Period *Thsing-thaï*, first year, ninth month, 38th day of the cycle (Oct. 14). The collection *Sin-ou-taï-sse* simply says at this date "there were many shooting stars all at once."

2. "934. Indictione 4. Defunctus est Joannes Abbas II. Kal. Aprilis, fer. 2. Et in ipso Anno apparuerunt signa in coelo de stellis quae videbantur hominibus aliae cadere, aliae fulgere sicut faculae XIV die intrante mense Octobri Luna 2." *Notes at the end of Chronicon Cavense: Muratori, Rer. Ital. Scrip.*, vii, 961. Also in *Annales Casinates: Pertz*, iii, 172. Quoted by Mr. Herrick. The year of the indiction is in error, as the day before the Kalends of April was not Monday, in the year 931.

3. "934. Igneae Remis in Coelo acies visae sunt discurrere, et quasi serpens igneus, et quaedam iacula ferri pridie Idus Octobris mane ante lucis exortum. Mox subsecuta est pestis diversis afficiens humana corpora morbis." *Chronicon Frodoardi: Dom. Bouquet, Recueil des Hist. des Gaules, &c.*, viii, 189. Also in *Pertz*, iii, 382, and in *Dom. Bouquet*, viii, 166. Quoted by Mr. Chasles.
Nearly the same account is given in *Hugonis Chronicon: Pertz*, viii, 359; in *Richeri Hist.: Pertz*, iii, 586; and in the *Chronicon Virdunense: Dom. Bouquet*, viii, 290.

4. By a change of the year, the following quotation (first cited by Mr. Frähn) from *Eutychii .... Annal.*, ii, 529, would refer to the same display.

وكان فى مصر زلزلة عظيمة ثالث ذى القعدة من هذه السنة واضطربت
الكواكب الشهب اضطبارا شديدا

And there was an earthquake, in Egypt, on the third day of Dhu-l-Ḳa'dah of this year [A.H. 323]; and flaming stars struck against one another violently.

The 3d day of Dhu-l-Ḳa'dah of 323, A. H., is the 4th of October, A. D. 935. But the same day of the year 322 is the 15th of October, A. D. 934.

The European chroniclers seem to imply that the shower was on the morning of the 14th of October. The Chinese and Arab accounts, on the contrary, point to the morning of the 15th. It is to be noticed that the Chinese observer does not speak of a very large number of shooting stars. The Arab account is quite indefinite, the shooting stars being mentioned only in connection with the earthquake. Moreover, all Arab dates which are not accompanied with the day of the week are liable to an error of one, two, or three days. I shall use the date Oct. 14th.

IV. A. D. 1002.

"1002. Période *Khien-ping*, 5e année, ... 9e lune, ... le jour *wou-su* (14 Octobre), il parut encore des milliers de petites étoiles qui entrèrent dans le groupe *Koueï* (θ, γ, δ, Cancer) et allèrent jusqu'au groupe *Tchoung-taï* (λ, μ, grande Ourse). En général, on voyait une grande étoile suivie d'une dizaine de petites étoiles. Parmi elles, on aperçut deux étoiles grosses comme un dixième de boisseau: celles-ci allèrent, l'une jusqu'à l'étoile *Lang* (Sirius), l'autre jusqu'au *Teou* du midi (φ, σ, τ, Sagittaire) et elles disparurent." E. Biot, *Catalogue*, &c., p. 42.

A.D. 1002. Period *Khien-ping*, fifth year, ninth month, 35th day of the cycle (Oct. 14th), there were seen moreover thousands of small stars, which appeared in the group θ, γ, δ, Cancri, and went as far as the group λ, μ, Ursae Majoris. Generally a large star was seen followed by a half score of small stars. Among them were seen two stars as large as a quart measure; these went, one to the star Sirius, the other to the group φ, σ, τ, Sagittarii, and vanished.

The date in this case I take to be the morning of the 15th of October, for the reason before given. Probably the radiant at this time was in Cancer, rather than in Leo.

V. A. D. 1101.

"1101. 17 Octobre. Visae sunt stellae de coelo cadere." *Chron. S. Maxentii: Labbe*, ii, 217, as quoted by A. Perrey, *Comptes Rendus*, xiv, 72.

VI. A. D. 1202.

The following accounts of a shower in this year are cited by Mr. Frähn from the Arab writers (*Bull. de l'Acad. de St. Pet*, iii, 314).

1. From Suyûṭî's *Ḥusn* (cod. 525 Acad. Sc., fol. 342):

وفى سنة تسع وتسعين وخمسماية فى ليلة السبت سلخ المحرم ماجت
النجوم فى السماء شرقا وغربا وتطايرت كالجراد المنتشر يمينا وشمالا ودام
ذلك الى الفجر وانزعج الخلق وضجوا الى الله تعالى بالدعاء ولم يعهد
مثل ذلك الا عام البعث وفى سنة احدى واربعين ومايتين

And in the year 599, on the night of Saturday, on the last day of Muḥarram, stars shot hither and thither in the heavens, eastward and westward, and flew against one another, like a scattering swarm of locusts, to the right and left; this phenomenon lasted until day-break; people were thrown into consternation, and cried to God the Most High with confused clamor; the like of it never happened except in the year of the mission of the Prophet, and in the year 241.

2. From Dhahabî's *Duwal al-Islâm* (cod. No. 524 Acad. Sc.):

وفى سنة تسع وتسعين وخمسماية فى اولها ماجت النجوم ببغداد
وتطايرت شبه الجراد ودام ذلك الى الفجر وضج الخلق بالابتهال الى الله
تعالى

And in the year 599, at the beginning of the year, stars shot hither and thither at Baghdâd, and flew one against another, like a swarm of locusts; this phenomenon lasted until day-break; and people cried out in supplication to God the Most High.

3. From Abu-l-'Abbâs ad-Dimashḳî's *Akhbâr ad-Duwal* (cod. 529 Acad. Sc., p. 68):

وفى سنة تسع وتسعين وخمسماية فى سلخ المحرم ماجت النجوم وتطايرت
تطاير الجراد ودام ذلك الى الفجر وانزعج الخلق الى الله تعالى ولم يظهر
ذلك الا عند ظهور رسول الله صلى الله عليه وسلم .

And in the year 599, on the last day of Muharram, stars shot hither and thither, and flew one against another, like a swarm of locusts; this phenomenon lasted until day-break; people were thrown into consternation, and made importunate supplications to God the Most High; there was never the like seen except on the coming out of the Messenger of God—on whom be benediction and peace!

4. From Hâji Khalfah's *Taḳwîm at-Tawârikh:*

سنة ٥٩٩ تموج نجوم در اسمان در شب كامل سلخ محرم

In the year 599 there was a shooting hither and thither of stars in the heavens, during the whole night of the last day of Muḥarram.

The last day of Muḥarram, A. H. 599 was Saturday, Oct. 19th, A. D. 1202. As the days are counted from sunset to sunset, the night before Saturday is here spoken of.

VII. A.D. 1366.

1. "Vindo o anno de 1366, sendo andados xxii dias do mes de Octubro, tres meses antes do fallecimento del Rei D. Pedro (de Portugal), se fez no ceo hum movimento de estrellas, qual os homẽes não virão nem ouvirão. E foi que desda mea noite por diante correrão todalas strellas do Levante para o Ponente, e acabado de serem juntas começarão a correr humas para huma parte e outras para outra. E despois descerão do ceo tantas e tam spessas, que tanto que forão baxas no ar, parecião grandes fogueiras, e que o ceo e o ar ardião, e que a mesma terra queria arder. Oeco parecia partido em muitas partes, alli onde strellas não stavão. E isto durou per muito spaço. Os que isto virão, houverão tam grande medo e pavor, que stavão como attonitos, e cuidavão todos de ser mortos, e que era vinda a fim do mundo." Duarte Nunez do Lião; *Chronicas dos Reis de Portugal reformadas*, Parte 1, Lisb. 1600, fol., 187; quoted by Humboldt, *Kosmos*, Stuttgart and Tübingen, 1850, iii, 621.

In the year 1366, and xxii days of the month of October being past, three months before the death of the King Don Pedro (of Portugal), there was in the heavens a movement of stars, such as men never before saw or heard of. From midnight onward, all the stars moved from the east to the west; and after being together, they began to move, some in one direction, and others in another. And afterward they fell from the sky in such numbers, and so thickly together, that as they descended low in the air, they seemed large and fiery, and the sky and the air seemed to be in flames, and even the earth appeared as if ready to take fire. That portion of the sky where there were no stars seemed to be divided into many parts, and this lasted for a long time. Those who saw it were filled with such great fear and dismay, that they were astounded, imagining they were all dead men, and that the end of the world had come.

2. "Eodem anno (i. e. 1366) die sequenti post festum xi millia virginum, ab hora matutina usque ad horam primam visae sunt quasi stellae de coelo cadere continua et in tanta multitudine, quod nemo narrare sufficit." *Chronicon Ecclesiae Pragensis*, cited by Boguslauski in *Pogg. Ann.*, xlviii, 612.

3. "1366. Scintillatio stellarum, et hoc factum est in nocte undecim milium virginum." *Annales Veterocellences: Pertz*, xvi, 45.

The feast of the eleven thousand virgins is the 21st of October. The first account implies that the shower was on the morning of the 23d of October. The second account is not inconsistent with that time, although the most natural inference from the passage is that it was on the morning of Oct. 22d.

VIII. A. D. 1533.

1. "1533. Période *Kia-tsing*, 12e année, 9e lune, jour *ping-tse*, (24 Octobre),..... Du quatrième au cinquième coup de tambour (de 2 à 4 heures du matin), dans les quatre parties du ciel, il y eut une quantité innombrable d'étoiles filantes, grandes et petites, allant ensemble en ligne droite et transversale: cela dura jusqu'au jour." E. Biot, *Catalogue, etc.*, p. 208.

A.D. 1533. Period *Kia-tsing*, twelfth year, ninth month, the 13th day of the cycle (Oct. 24th),..... from the fourth to the fifth watch (from 2 to 4 A. M.), in the four parts of the heavens, there were innumerable shooting stars, great and small, moving together in straight and oblique lines. This continued until daylight.

2. "*Casus stellarum anno* 1533. 24. Octob. noctu visa sunt multa millia stellarum cadere et quasi inter se dimicare, ut quasi incensum videretur coelum; sunt omnes tales ignes delati ab omnibus coeli partibus Hallim versus." From a manuscript in the library of Prince Fürstensberg, quoted by A. Savarik in *Pogg. Annalen der Physik*, 1863, No. 8, p. 643.

The manuscript volume in which this passage is found was written at Wittenberg between A. D. 1520 and 1540. Halle is S. 43° W. from Wittenberg. I suppose that these accounts refer to the morning of the 25th of October.

IX. A.D. 1602.

"1602. Même période (*Wang-li*), 30e année, 9e lune, ... jour *sin-sse* (27 Octobre), on vit plusieurs centaines de petites étoiles qui se séparaient et se réunissaient." ...... A second account is as follows:

"Pendant la nuit, à la cinquième heure, il parut au N. E. une étoile grande comme un oeuf de poule et d'une couleur blanc bleuâtre; sa queue avait de l'éclat. Du N.E. des étoiles *Hia-taï* (ν, ξ, grande Ourse), elle alla jusqu'à ce qu'elle s'approchât de l'O. Au midi, il parut aussi une étoile grande comme un rouleau de pierre pour écraser le grain; elle était de couleur bleu blanchâtre: sa queue rayonnait et sa lumière éclairait la terre. Elle parut au S. O. de *Tsan* (Baudrier et quadrilatère d'Orion) et s'avança jusqu'aux étoiles de la Ménagerie céleste (γ, δ, ι, τ, Eridan). Aprés cette apparition, il y eut deux petites étoiles qui suivirent la grande, et, après encore, il y eut plusieurs centaines d'étoiles filantes, grandes et petites, mêlées et confondues, qui suivirent la même direction." E. Biot, *Catalogue, etc.*, p. 210.

A.D. 1602. Period *Wang-li*, thirtieth year, ninth month, 18th day of the cycle (Oct. 27th, O. S.), several hundred small stars were seen, which parted from each other, and came together again.

During the night, at the fifth hour, a star appeared in the N.E. as large as a hen's egg, and of a blueish white color. It left a bright train. From N.E. of the stars

ν and ξ Ursæ Majoris it went nearly to due west. In the south appeared another star as large as a pestle for pounding grain. Its color was whitish blue, its train gleamed, and its light illumined the earth. It appeared S.W of the belt and quadrilateral of Orion, and passed to the group γ, δ, ε, τ, Eridani. After this were two small stars which followed the large one, and still later there were several hundred shooting stars, great and small, mixed and confused, which followed in the same direction.

X. A. D. 1698.

Mr. Wartmann, of Geneva, has cited a notice of unusual numbers of meteors seen on the 9th of November, A.D., 1698.

XI. A. D. 1799.

The remarkable display on Tuesday morning, Nov. 12th, 1799, is well known from Humboldt's description of it as seen by him and Bonpland at Cumana, in S. America. This is the first shower of the geographical extent of which we can form any very clear ideas.

Humboldt's account is not entirely consistent with itself, and is a very inadequate description of what we know the display must have been. It seems to have been originally written (at least in part) while he had the impression that it was a local phenomenon. He says:[3]

"From half after two, the most extraordinary luminous meteors were seen toward the east...... Thousands of bolides and falling stars succeeded each other during four hours. They filled a space in the sky extending from the true east 30° toward the north and south. In an amplitude of 60° the meteors were seen to rise above the horizon at E.N.E. and at E., describe arcs more or less extended, and fall toward the south, after having followed the direction of the meridian. Some of them attained a height of 40°, and all exceeded 25° or 30°...... Mr. Bonpland relates, that from the beginning of the phenomenon there was not a space in the firmament equal in extent to three diameters of the moon, that was not filled at every instant with bolides and falling stars...... The Guaiqueries in the Indian suburb came out and asserted that the firework had begun at one o'clock..... The phenomenon ceased by degrees after four o'clock and the bolides and falling stars became less frequent; but we still distinguished some toward the northeast a quarter of an hour after sunrise."

The same phenomena were seen at S. Fernando d'Apura, 300 miles S.W. of Cumana; at Marao, more than 200 miles farther in the same direction; and also near the Equator, over 700 miles south of Cumana.[4] The Count of Marbois, at Cayenne, says:[5]

"The northern part of the sky was seen all on fire. Innumerable falling stars traversed the heavens during an hour and a-half, and diffused so vivid a light that these meteors might be compared to the blazing sheaves shot out from a firework."

Andrew Ellicott, Esq., recorded in his journal as follows:[6]

"Nov. 12th, 1799, about three o'clock, A. M., I was called up to see the shooting of the stars, (as it is commonly called). The phenomenon was grand and awful; the whole heaven appeared as if illuminated with sky-rockets, which disappeared only by the light of the sun after daybreak. The meteors, which at any one instant of time appeared as numerous as the stars, flew in all possible directions, except from the earth, toward which they all inclined more or less...."

[3] *Personal Narrative of Travels to the Equinoctial Regions*; ..... trans. by Helen Maria Williams, 8vo, London, 1822, iii, 331–333.
[4] *Pers. Narr.*, pp. 335, 336. [5] *Ibid.*, p. 337.
[6] *Trans. Amer. Phil. Soc.*, vi, 28. Also *Ellicott's Journal*, 4to, 1814, p. 248.

He was then in N. lat. 25°, near the edge of the Gulf Stream. He was afterward informed that the same phenomena were witnessed over a large portion of the West India Islands, and as far north as St. Mary's, in lat. 30° 42′, where it appeared as brilliant as with him off Cape Florida.

The Moravian missionaries in Labrador and Greenland recorded the same shower in their meteorological Journal.

"On the 12th of Nov., there was at Nain and Hoffenthal a strange appearance in the air, which greatly frightened the Eskimos. For there fell down to earth in the four quarters of the heavens, about daybreak, very many fireballs, some of which seemed to be half an ell in diameter. This phenomenon was at the same time seen at New Herrnhut and Lichtenau in Greenland. ...." *Gilb. Annalen der Physik*, xii, 217.

In England, the clouds and rain rendered it in many places impossible to see these meteors. Yet in some localities they were observed, while in others single meteors and flashes of light were so remarkable as to be noticed in several of the newspapers.[7] The first of the following quotations is from the *New Castle Chronicle*, given in the *Monthly Magazine* for Dec. 1799, p. 917.[8] The other is from the *Gentleman's Magazine*, Nov., 1799, p. 987. It is evidently from a newspaper.

"On Tuesday morning, the 12th of November, several meteors, or balls of fire, were seen at Greatham, near Hartlepool, and other parts of that neighborhood. They were first observed between five and six o'clock in the morning, in an eastern direction, and continued falling in succession, and together, till daybreak. The atmosphere was very clear, and the moon, which was at full, shone with uncommon brilliancy. The meteors at first appeared like what are vulgarly called shooting or falling stars, which soon became stationary; they then, as it were, burst, but without any perceptible report, and passed to the northward, leaving behind them beautiful trains of floating fire in various shapes, some pointed, some irradiated, some in sparks, and others in a large column. The fire balls continued falling near two hours, and were succeeded till near eight o'clock by slight flashes of lightning. The general appearance was sublimely awful, particularly to the Hartlepool fishermen, then at sea...."

"HULL, Nov. 12. This morning, between 5 and 6, the heavens exhibited an awfully grand appearance.... The middle region of the air was illuminated by meteors crossing each other in different directions, and leaving behind them long sparkling trains, which were visible for two or three minutes after these luminous bodies had disappeared."

In Germany, Mr. Zeissing, at Isterstadt, near Weimar, entered upon his meteorological journal an account of bright streaks and flashes seen that morning in the sky.[9] Bright flashes, and extraordinary appearances, were seen at Carlsruhe and at Weissenfels.[10]

St. Mary's, in Florida, is more than 90° in long. west of Isterstadt, and Lichtenau is more than 60° north of places in South America where the shower was seen. It is very evident that more shooting stars were to be seen in America than in Europe. There is every reason to believe that this shower, which was

[7] See *Monthly Magazine*, Dec., 1799, pp. 917, 920, 921, 922, and Feb., 1800, p. 24.
[8] Also, *Gent. Mag.*, 1799, p. 1185.
[9] Quoted by J. W. Ritter, *Gilb. Annalen*, xv, 109.
[10] *Gilb. Annalen*, xiv, 116, and xiii, 255.

visible in Labrador and in Florida, would have been seen at intermediate places but for the clouds. At Salem and New Haven it was cloudy on that morning.

XII. A. D. 1832.

On the morning of Nov. 13th, A. D., 1832, unusual numbers of shooting stars were seen throughout Europe. Descriptions of the display were given at once in many of the newspapers and scientific journals. The most important of these were collected and published by Prof. Nöggerath, of Bonn,[11] and Prof. Gautier, of Geneva.[12] The names of the places where the shower was said to have been witnessed, together with some expressions indicating its intensity, will enable one to form a fair idea of the character of the display. The places farthest east are mentioned first.

In the island of Mauritius,[13] "the number of the meteors was so great that it was impossible to count them." At Orenberg,[14] north of the Caspian Sea, "the sky was filled with shooting stars." At Mocha,[15] in Arabia, "it appeared like meteors bursting in every direction." At Sudscha,[16] in Russia, "several hundred meteors were seen between 5 and 8 o'clock, so that while a person turned to look at one, others would appear at the side, and behind him," and yet "sometimes minutes passed without one being seen." They were seen at Kursk,[17] Ruiljsk,[17] Odessa,[18] St. Petersburg,[18] Riga,[18] Warsaw,[17] and Berlin.[17] At Suczawa,[19] in the Bukowina, "the shooting stars fell so fast as to be compared to an actual rain of fire." It was reported as witnessed in various places in Switzerland; at Frankfort,[20] Stuttgart,[20] and Carlsruhe,[20] in South Germany; at Brussels and Liege, in Belgium; and near the lower Rhine at Treves,[20] Cleves,[20] Düren,[20] Aix la Chapelle,[20] Lennep,[20] Bonn,[20] and Cologne.[20] At Salz-Uffeln, in Westphalia, "there were often three or four at once in the sky." At Düsseldorf,[21] Mr. Custodis counted 267 meteors between 4 and 7 o'clock. Mr. Le Verrier saw them[22] and says, "it would have taken several hours to count those visible at one instant, supposing them fixed." (!!!) At Grenoble,[23] an observer estimated that he saw at least 60 in 25 minutes. At Limoges,[24] workmen were terribly frightened by the meteors. Near

[11] *Schweigger's Journal für Chemie und Physik*, lxvi, 328-343, and lxvii, 263.
[12] *Bibliothèque Universelle de Genève*, 1833, li, 189-207. This article I have not seen.
[13] *Comptes Rendus*, v, 121.
[14] *Astron. Nachrichten*, xiii, 241.
[15] *This Journal*, xxvi, 136.
[16] *Moskauer Wochenzeitung;* quoted in *Pogg. Annalen*, xxix, 448.
[17] *Poggen. Annalen*, xxix, 448, 451.
[18] *Schweig. Jour.*, lxvi, 343.
[19] *Baumgartner's Zeitschrift*, 1833, ii, 11; quoted in *Pogg. Ann.*, xxix, 448.
[20] *Schweigger's Jour.*, lxvi, 328 ff.
[21] *Ibid.*, lxvii, 188.
[22] *Comptes Rendus*, ix, 808.
[23] *Schweigger's Jour.*, lxvii, 264.
[24] *Comptes Rendus*, v, 562. I take it for granted that the date is in error one day.

Beverly,[25] in England, "there was hardly a minute during the night without a shooting star, and often 20 were seen at once." At other places in the north of England, "they fell in immense numbers." At Malvern,[26] 48 were counted in 5 minutes. At York,[27] 25 were counted during the first half hour of the exhibition. Prof. Schaeffer,[28] on shipboard off Pernambuco (W. lon. 35°), entered upon his diary that numerous meteors were seen on that night. His account, however, implies that the display was not remarkable. Capt. Briggs,[29] in N. lat. 43° and W. lon. 40°, saw them quite numerously; but adds, "toward morning only a few in an hour were seen."

The shower was not apparently observed in the United States. And yet it was not cloudy, for the day fell in the middle of a period of very fair weather. I am indebted to Prof. Whitney and Mr. J. S. Fisk for extracts from the meteorological records preserved at Washington and Albany. At 39 of the 41 U. S. military posts it was fair weather on the 12th of November, and at 30 of them it was fair on the 13th. Seven of the remaining eleven were in the two States, Maine and Louisiana. At only two of thirty-nine academies in N. Y. State was it cloudy on the afternoon of the 12th, and at only four was it cloudy on the forenoon of the 13th. In all these 80 meteorological journals not one word is said of unusual numbers of shooting stars on that night. When, two years later, the subject of the annual return of the meteors was so fully discussed, no one remembered to have seen, or heard of them, here in 1832. It is incredible that the meteors could have been as numerous in America as in Europe, and have thus escaped observation. It is fair to conclude that the shower as a very unusual display ended soon after daybreak in Western Europe, or soon after two o'clock in the Atlantic States.

XIII. A. D. 1833.

The much more remarkable shower of Nov. 13th, 1833, has been so fully described by Prof. Olmsted,[30] and Prof. Twining,[31] that the details need not be repeated. It extended, at least, from Cuba to Greenland, and from W. lon. 61° to W. lon. 100°, and how much farther in each direction is unknown. The mate of a vessel then in W. lon. 61°, N. lat. 36°, reports that the meteors were comparatively few. None were observed by the officers of two vessels, one in W. lon. 41°, N. lat. 2°, the other in W. lon. 20°, N. lat. $51\frac{1}{2}$°, though both reported clear skies.[32] It is not

[25] *Quetelet's Corr. Math. et Phys.*, ix, 453.
[26] *Phil. Mag.*, [3], iii, 87; quoted in *Pogg. Annal.*, xxix, 448. I suppose the date assigned to be one week in error.
[27] *York Herald*, quoted in *this Journal*, xxvi, 136.
[28] *This Journal*, xxxiii, 132.
[29] *Ibid.*, xxvi, 349.
[30] *This Journal*, xxv, 363, and xxvi, 132.
[31] *Ibid.*, xxvi, 320.

certain what trust is to be given to this evidence, negative at the best.

Many vessels on the eastern Atlantic had cloudy skies.[32] In Europe it seems to have been overcast, though how generally I have no means of learning. At London, it was lightly overcast on the 13th. At Cambridge, Greenwich, and Königsberg, no astronomical observations appear to have been made from 10 o'clock, P. M., of the 12th, until the evening of the 13th. At Geneva, it was cloudy and snowing both days, while at Great St. Bernard there were broken clouds.[33] That no place on the eastern continent, where there were civilized men, had clear skies, seems incredible. In view of the numerous notices of the far less brilliant display of the preceding year, it would seem also certain that if a shower had been seen, we should have descriptions of it. Capt. Briggs says that it was clear at Canton, in China, and that there could have been no extraordinary display there.[34]

The display began here about midnight, but, judging from the tenor of the conflicting accounts, it appears not to have been very extraordinary until between 2 and 3 o'clock, New Haven time. This was after sunrise in Europe. I presume that a moderate display would have been visible there late in the morning, if the skies had been clear.[35]

[32] *Ibid.*, xxv, 399. [33] *Bibliothèque Univ. de Genève* for 1833.

[34] *This Journal*, xxvi, 349.

[35] If we knew the true dates, perhaps these showers might be added to the list.

A. D. 1199. "At the beginning of the year [A. H. 599, which began Oct. 22d], the stars were seen coursing through the heavens....." Abd-allatif, *Relation de l'Egypte*. See *this Journal*, xl, 355.

"Anno Domini MCCCIC. Eclipsis solis facta est secundo Calend. Octobris. Stellae quoque instar ignis de caelo cadentes in plerisque Italiae locis visae sunt." *Annales Forolivienses: Muratori, Rer. It. Scr.*, xxii, 200.

A. D. 1766. Humboldt says (*Pers. Narr.*, iii, 333,) that the older inhabitants of Cumana remembered that the great earthquakes of 1766 were preceded by displays like that of 1799. These earthquakes began Oct. 21st, 1766, and recurred at intervals through a whole year. Again he says (p. 346) that such phenomena were witnessed about thirty years before 1799 at Quito. So great was the number of shooting stars that the mountain seemed to be in flames.

[To be continued.]

ART. XXXVII.—*Note on the Product of the Reaction between the Monosulphid of Potassium and the Bromid of Ethylene, and on several compounds derived from it;*[1] by J. M. CRAFTS.

WHEN an alcoholic solution of monosulphid of potassium is mixed with the chlorid of ethylene, no reaction takes place immediately, but the mixture, after remaining exposed to the air several days, deposits a precipitate, whose composition is expressed by the empyrical formula, C_2H_4S. When higher sulphids of potassium are employed, compounds containing more sulphur than the preceding are still more readily obtained. These bodies, discovered by Löwig and Weidmann and described by them as sulphids of ethylene, can not be distilled, but are decomposed by heat into various products, of which the principal is a sulphuretted oil, whose composition has not been determined. (Vide *Gmelin*, vol. iv.) No direct combinations of these sulphids with other bodies have been obtained, and they must be considered as among those of the non-nitrogenous organic compounds, whose chemical character and properties are the least accurately known.

It was with a view to studying the properties of the monosulphid of ethylene, and particularly the action of chlorine and bromine upon it, that I attempted to prepare that body by means of the monosulphid of potassium and the bromid of ethylene, instead of with the chlorid, because, in similar double decompositions, bromine in combination with organic radicals is more easily replaced by other elements or radicals than chlorine. The analogy was found to hold good in the present instance in so far that the bromid of ethylene is more easily attacked than the chlorid, but the products of this reaction differ entirely from those obtained by Löwig and Weidmann. This remarkable fact probably finds its explanation in the supposition of those chemists, that the sulphid of ethylene obtained by them was not the direct product of a double decomposition between the monosulphid of potassium and the chlorid of ethylene, but resulted from destruction of the immediate product of the reaction, through the oxydizing influence of the air.

If equal parts of bromid of ethylene and monosulphid of potassium, in solution in 6 parts of alcohol, are mixed together, a violent reaction, attended with disengagement of heat, commences after a few minutes: the whole mass becomes nearly solid from the formation of a voluminous precipitate, and at the

[1] The latter portion of this research, relating to the sulphid of ethylene and its combinations with oxygen and with bromine, has been published in the *Comptes Rendus* of the French Academy of Science, liv, 1277, and lv, 332. The atomic weights used in this note are H = 1; C = 12; O = 16; S = 32; Br = 80.

same time a small quantity of the vapor of monobromated ethylene, unmixed with ethylene (olefiant gas), is given off as gas. If the precipitate is washed with warm water to free it from bromid of potassium and from the excess of monosulphid of potassium employed, there remains on the filter a white, amorphous body containing sulphur, which leaves no residue after incineration on platinum foil. This body is at first slightly soluble in water, and the solution gives a light yellow precipitate with salts of lead, and a white one with salts of mercury; but after having been dried in the air it becomes entirely insoluble in water.

The amorphous body prepared as above is very slightly soluble in alcohol, ether and bisulphid of carbon, but a small quantity of a crystallized substance can be extracted from it by boiling a long time in these solvents. On heating with ether, or with bisulphid of carbon at a higher temperature in a sealed tube, it is gradually decomposed with formation of a large quantity of the same crystallized substance, together with an oily product. This decomposition is complete only after several days at a temperature of 150° C., but is much more rapid at 170°–180° C.

Although the ether and the bisulphid of carbon are probably not without chemical action on the amorphous body, the principal product of its decomposition in sealed tubes is the same as that obtained from it by the action of heat alone; and indeed the latter means was exclusively resorted to in order to obtain the crystallized substance in quantity sufficient for the study of its properties.

The action of heat on the amorphous body can be best observed by placing the substance in a bent tube, in an oil-bath, which is gradually heated and its temperature observed by means of a thermometer, while a current of air is passed through the tube to facilitate the sublimation of volatile products. In order to examine the gases given off, the air and gases together, after leaving the tube, are conducted through water, which retains those that are soluble. The products from different preparations were treated in this manner, and all gave the same results. As the temperature rises to 160° C. a deposit of crystals is seen gradually collecting in the cool part of the tube. The crystallized sublimate augments largely in quantity between 160° and 195° C.; and at this temperature a little bromhydric acid is given off, as may be seen by testing the water through which the gas is passed. At 195°–205° the crystallized substance distils in great abundance, while a large quantity of bromhydric acid is given off. Above 205° C. the distillation of the crystallized substance nearly ceased, and the small quantity which passes over from 205° to 240° is mixed with a yellow oil, of which not enough was obtained to determine its properties. At this temperature a trace of sulphuretted hydrogen, besides bromhydric acid, is found in solution in the water.

Of the different portions of the amorphous body whose analyses are given below, the melting points of Nos. II. and III. were near 145° C.; but as the substance first softened and then became partly liquid before it melted entirely, this point could not be very accurately determined. The melting point of No. V, which was more precisely marked, was about 125° C.

The substance was prepared for analysis by washing carefully with warm water and drying at 60°–70° C. Some portions were also washed with alcohol to insure that no bromid of ethylene remained attached to them, but this precaution was found unnecessary.

Analyses made of different preparations gave the following results:

	I.	II.	III.	III.	IV.	IV.
C	36·81	34·96	34·27	....	34·20	34·49
H	5·86	5·49	5·78	....	5·93	5·36
S	44·94	45·98	42·95	43·05	42·05	42·12
Br	12·56	13·76	17·49	....	S (by loss)	18·00
	100·17	100·19	100·49			

In order to determine in what degree the relative proportions of the bodies entering into the reaction might influence the composition of the product, in one experiment (No. V) 1 part bromid of ethylene was treated with ½ part monosulphid of potassium in alcoholic solution (= 1½ equivalents); in another (VI) 1 part of bromid of ethylene was treated with 2½ parts monosulphid of potassium (7 equivalents) and the mixture was allowed to stand 48 hours after the formation of the precipitate. A determination of bromine gave:

	V.	VI.
Br =	27·91 &c.	11·95

These analyses show that the immediate products of the reaction between the bromid of ethylene and the monosulphid of potassium is not, as might have been expected, the sulphid of ethylene, C_2H_4S; but is a body whose composition varies widely in the different preparations, and which contains a considerable amount of bromine, even though the quantity of monosulphid of potassium employed may have been largely in excess. The question arises, is there any relation between the percentage amounts of the constituents of this body which is constant in all the analyses, and which may give a clue to determine its composition?

An inspection of the figures given above shows that in all the analyses the percentage of C is to that of H as 6:1, the same ratio that the percentages of those elements bear to one another in ethylene, so that it would appear that this radical remains

intact during the reaction; further, as will be seen by the table below, if the bromine in each analysis be supposed combined with the amount of carbon required to form with it bromid of ethylene, the remainder of the carbon stands very nearly in the same atomic relation to the sulphur that these elements bear to one another in the sulphid of ethylene, namely, 2 : 1; so that the idea naturally suggests itself that the body in question may be a bromid of ethylene in which a part of the bromine has been replaced by sulphur.

The numbers in the table were obtained by multiplying the percentage amount of bromine by $\frac{3}{20}$, subtracting the product from the percentage of carbon, and dividing the remainder by 12, the atomic weight of carbon, and then comparing the number thus obtained with the percentage of sulphur divided by its atomic weight, 32.

	I.	II.	III.	IV.
C:S =	2·07 : 1	1·92 : 1	1·96 : 1	1·98 : 1

There is, however, a fact which speaks strongly against the above hypothesis, founded on these numerical relations, namely, that the bromine in the amorphous, sulphuretted compound is disengaged at a not very elevated temperature in the form of bromhydric acid, a property which indicates a molecular arrangement of the bromine, with reference to the hydrogen, very different from that in the bromid of ethylene, as this latter can be heated to a very high temperature without suffering decomposition. A theory in regard to the nature of a body, which depends merely on its percentage composition and is at variance with its chemical properties, is inadmissible; and in the absence of any reaction which could throw light on the subject, the rational formula of the immediate product of the action of bromid of ethylene on the monosulphid of ethylene must be left undetermined.

It is worthy of notice, that, although a crystallized substance is easily obtained by the decomposition of the amorphous body by heat, its product of oxydation is not among those which are formed, when the latter is attacked by nitric acid at the ordinary temperature.

The crystallized sulphid of ethylene can be obtained in considerable quantity by the decomposition of the amorphous compound in the manner already mentioned. To obtain it perfectly pure, it is sufficient to wash the crystals, after they have been sublimed several times, with a little ether, and to press them between folds of filter-paper.

For analysis were taken:

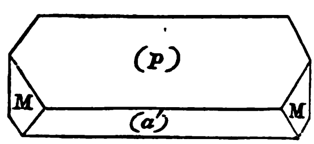
I. 0·1785 grams substance, obtained 0·2540 grms. CO_2 and 0·1082 grms. HO_2
II. 0·1790 " " " 0·6946 " $Ba_2O\ SO_3$
III. 0·2581 " " " 0·9845 " $Ba_2O\ SO_3$

		II.	III.	Theory C_2H_4S
C =	39·93	....	....	40·00
H =	6·92	....	....	6·67
S		53·25	53·37	53·33
				100·00

This analysis leads to the empyrical formula, C_2H_4S.

The sulphid of ethylene is a solid body, somewhat volatile at the ordinary temperature, and has a peculiar odor, which although disagreeable, is not nearly so strong as that of mercaptan. It is slightly soluble in water; in alcohol, ether and bisulphid of carbon, it is easily soluble, and more so when the solvents are hot than at the ordinary temperature.

By gradual evaporation of its solution in the bisulphid of carbon, the sulphid of ethylene may be obtained in transparent crystals of considerable size with brilliant surfaces, which, however, after a short time become dimmed by the slow evaporation of the substance in the air. I am indebted to the kindness of Mr. Friedel for the measurement of these crystals. They belong to the clinorhombic system.



In the larger crystals, the base (P) is usually much developed; in the smaller, the faces (P) and (a') are nearly equally developed. The faces observed are, ∞P=(M); 0P=(P), and P∞ =(a'). Vertical axis on inclined axis =47° 59′. Prismatic edge of base on inclined axis =27° 38′.

		Angles measured.	Angles calculated.
P : a'	=	81° 44′	81° 13′
P : M		112 30	
M : M		69 44	
M : a'		111 11	

In polarized light a system of rings is observed very oblique to the face (P), and another almost normal to (a').

The solidifying point of the crystals, after they have been purified, is 112°. The boiling point is 199°–200° C.

The sulphid of ethylene does not combine with ammonia in aqueous or in alcoholic solution, or even when heated to its boiling point in an atmosphere of the gas. It is readily attacked by concentrated nitric acid; red fumes are given off, and a crystallized product of oxydation is formed. Only traces of sulphuric acid are produced, even when fuming nitric acid is employed. The oxydation by means of bromine in the presence of water gives rise to the same crystallized product as that obtained with nitric acid.

When dry chlorine gas is passed over the sulphid of ethylene, this latter is attacked with energy, and chlorhydric acid is given off, even though pains may have been taken to prevent the temperature from rising; chlorhydric acid is also disengaged when chlorine is passed into a solution of the crystals in the bisulphid of carbon.

Bromine unites directly with the sulphid of ethylene, forming a definite compound, and if care has been taken to prevent the temperature from rising, no bromhydric acid is given off.

A determination of density of vapor was made, by Dumas' method, on a portion of the crystals purified by repeated crystallization from bisulphid of carbon. The substance which remained in the balloon was entirely unaltered at the temperature (266°) of the experiment.

Temperature of balance,	= 24° C.
" " oil-bath,	266° "
Increased weight of balloon,	0·5535
Capacity of "	348 cubic centimetres.
Air remaining in "	1 c. c.
Barometer during the time of the experiment	=766·8 mm.
Density of vapor found,	= 4·213
Theory, $C_4H_8S_2$=2 vols. (H=1 vol.)=	4·1556

Another determination, made at the boiling point of mercury by Deville's method, failed, because the substance was decomposed at this temperature.

The determination given above necessitates the doubling of the empirical formula, C_2H_4S, of the sulphid of ethylene, in order to make it the rational formula in accordance with the law of Ampère: that one molecule of all bodies in the gaseous form occupies two volumes of space, if one atom of hydrogen is considered as occupying one volume. The sulphid in question would thus be the product of the condensation of two molecules of monosulphid of ethylene into one.

Condensed products of this nature, belonging to the ethylene group, have been made known by the researches of Wurtz and of Lorenço, in which a number of compounds have been discovered, where two, three and more molecules of oxyd of ethylene, C_2H_4O, are condensed into (occupy the place of) a single molecule; but in no instance is the formation of one of these stages of condensation unaccompanied by that of others of the same series. The crystallized sulphid of ethylene, on the contrary, is not accompanied by any other compound of similar nature and different atomic weight. Again, the oxyd of diethylene $\begin{pmatrix} C_2H_4O \\ C_2H_4O \end{pmatrix}$, and the still more condensed compounds of oxyd of ethylene, combine with two equivalents of bromine, and play the same part in the glycoles derived from them as the

oxyd of ethylene; while the crystallized sulphid of ethylene, if the formula is doubled, unites with four equivalents of bromine, and with four and even eight equivalents of oxygen.

It is therefore necessary, in assigning a rational formula to the sulphid of ethylene, to strike the balance between the weight that should be given to the analogy which ought to exist between this body and the oxyd of ethylene, and that which should be attached to the accordance of the formula with the law of Ampère. The latter consideration seems to be the more important one from the generality of the law relating to atomic volumes, and it is not improbable, that the anomaly mentioned will be explained, or at least generalized, on further study of the diatomic sulphids; but as an incertitude exists, I shall retain, in the present memoir, the formulæ for the sulphid of ethylene and for its compounds, which I assigned to them in my first communications to the French Academy of Sciences, when I was unacquainted with the density of vapor of the sulphid of ethylene.[1]

Oxyd of sulphid of ethylene.—This body is the only product of oxydation of the sulphid of ethylene by nitric acid at a temperature not exceeding 100° C. It is best prepared by treating the sulphid with a small excess of fuming nitric acid, and then washing, once with a small quantity of water, and afterward with ordinary alcohol until the product is freed from acid. An analysis of the body prepared in this way and dried at 100° C., gave:

	Gram.		Gram.			Gram.		
I.	0·2801	substance taken;	0·3230	CO_2	and	0·1365	H_2O	found.
II.	0·2104	" "	0·2410	"	"	0·1015	"	"
III.	0·1968	" "	0·6010	Ba_2OSO_3				

	I.	II.	III.	Theory C_2H_4SO.
C =	31·45	31·25	....	31·58
H =	5·41	5·36	....	5·26
S =	....	....	41·92	42·10
O =	....	....	....	21·06
				100·00

[1] Mr. Husemann, who obtained the sulphid of ethylene by another reaction, as well as by the one with monosulphid of potassium, and was occupied with its study at the same time as myself, was the first to publish a determination of its density of vapor in a note in the *Chem. Centralblatt* (1862, p. 497), which appeared a short time after the publication of my note in the *Comptes Rendus* (vol. liv, p. 1277); and he deduced from this determination the rational formula $\left(\begin{smallmatrix}C_2H_4S\\C_2H_4S\end{smallmatrix}\right)$, and named the body sulphid of diethylene. Mr. Husemann also studied the product of substitution of chlorine in the oxyd of sulphid of ethylene (the compound best suited to determine directly its rational formula), and obtained the body $\left(\begin{smallmatrix}C_2H_3ClSO\\C_2H_3ClSO\end{smallmatrix}\right)$ in crystalline form by the action of chlorine water on the sulphid of ethylene. The fact, that this body is the first product of substitution of chlorine in the oxyd of sulphid of ethylene, speaks rather against, than for, the doubling of the simplest formula, C_2H_4SO, although it can not be regarded as deciding the question, as would have done the existence of a compound $\left(\begin{smallmatrix}C_2H_3ClSO\\C_2H_4\ \ SO\end{smallmatrix}\right)$.

The oxyd of sulphid of ethylene is readily soluble in water, and still more so in an acid solution; it is but slightly soluble in alcohol and in ether. Its solution in water has at first a sweet taste which afterward becomes astringent.

From a perfectly neutral solution in water it can be obtained, by gradual evaporation, in crystals of considerable size, which have the appearance of rhombohedrons, and the terminal angle, measured with a hand goniometer, is 72°–73°. The crystals obtained from an acid solution are much smaller and more elongated, having the appearance of prisms.

The oxyd of sulphid of ethylene enters into no combination with ammonia or with mineral acids. It is destroyed by heating with a strong solution of caustic potash with formation of resinous products. It is not volatile, but supports a temperature of 200° C. before it is destroyed by heat. This oxyd is isomerous with thiacetic acid, (acetic acid in which an atom of oxygen is replaced by an atom of sulphur,) but it is not transformed into this acid by the action of alkalies.

The Deutoxyd of sulphid of Ethylene is the product of the further oxydation of the preceding oxyd by means of nitric acid, at a temperature higher than its boiling point.

If several grams of the protoxyd are sealed up with fuming nitric acid, in a stout glass tube, by means of the blast-lamp, and heated in an oil-bath to 120° or 130° C., only a very slight reaction takes place; but if the temperature is maintained one-half hour at 150° C., aggregations of small crystals filling up most of the lower part of the tube are formed, and on opening the tube a considerable quantity of a gas consisting in large part of hyponitric acid is disengaged.

The crystals, under the microscope, present the appearance of small prisms terminated by two faces forming an obtuse angle with one another. They are insoluble in water, and nearly so in ordinary nitric acid, but can be easily dissolved in fuming nitric acid, and the body is precipitated from this solution, in the form of a fine powder, on the addition of water. The deposition of the crystals in the sealed tubes results probably from the destruction in the process of oxydation of a portion of the fuming nitric acid, whereby water is set free, and also, perhaps, because they are less soluble in this acid when saturated with hyponitric acid than when pure.

Provided the oxydation has not been carried too far, an analysis of the crystals, taken from the tube and washed thoroughly with warm water, gives a little more carbon and hydrogen than correspond to the composition of the deutoxyd, showing that they still contain, as an admixture, a little of the protoxyd. The deutoxyd can however be obtained perfectly pure by dissolving the crystals in fuming nitric acid, precipitating by the

addition of water and then washing the precipitate with boiling water. The product thus obtained, and dried at 100° C. gave:

	Gram.		Gram.		Gram.
I.	0·2318	substance taken;	0·2210	CO_2	and 0·0985 H_2O found.
II.	0·1642	" "	0·4112	$Ba_2O\,SO_3$	

	I.	II.	Theory C_2H_4SO.
C =	26·00	....	26·08
H =	4·72	....	4·36
S =		34·36	34·78
O =		....	34·78
			100·00

To obtain the deutoxyd perfectly pure, the oxydation with nitric acid should not be prolonged beyond one-half hour, and the temperature should not exceed 150°, for the deutoxyd itself is capable of slight alteration, and, although its physical properties remain the same, it then contains a little less carbon and hydrogen than the theoretical amount, showing an admixture of a more oxygenated compound, from which it can not be separated, as from the protoxyd. No further stage of oxydation than the deutoxyd seems capable, however, of existing alone, and when the oxydation with nitric acid, in sealed tubes, is continued as far as possible, only the slightly altered deutoxyd, together with its ultimateproducts of decomposition, and no tritoxyd, are produced. The crystals obtained on heating with nitric acid one hour to 180° C., contained 25·20 p. c. C, and 4·80 p. c. H. Those obtained by heating three times, one-half hour each time, to 200° C., contained 25·22 p. c. C, and 4·37 p. c. H, instead of 26·08 p. c. C, and 4·36 p. c. H, which the composition of the deutoxyd requires. In each of these experiments considerable quantities of sulphuric acid, and also of a gas, probably carbonic acid, were formed, and in the second the oxydation was effected in three operations, in order to open the tube and permit the gas formed to escape between each one. Although the deutoxyd is thus ultimately decomposed into sulphuric acid, carbonic acid and water, it resists in a remarkable degree the action of so powerful an oxydizing agent at so high a temperature.

The deutoxyd of sulphid of ethylene does not lose in weight when heated to 150° C. in an air-bath, and even supports a temperature superior to 200° C. without apparent alteration.

It is not attacked by ammonia, but it is dissolved on boiling with a dilute solution of caustic potash or hydrate of baryta, and is not precipitated from the solution by the addition of an acid. The deutoxyd seems to be transformed by the action of these alkalies into a feeble acid, whose potash and baryta salts are soluble, but neither the salts nor the acid have been obtained in a crystalline form, and as they are accompanied by other products it has as yet been impossible to purify them, so that the exact nature of this transformation has not been determined.

The bromid of sulphid of ethylene.—It has already been mentioned that the sulphid of ethylene combines directly with bromine without disengagement of bromhydric acid. Whether this combination can take place in more than one proportion is a question of particular interest, and at the same time is one, which from the manner in which the union of the two bodies is effected can be easily resolved.

When a solution of bromine and another of sulphid of ethylene in bisulphid of carbon are mixed together in different proportions, one or the other being largely in excess, a light yellow colored precipitate is formed, which always has the same composition after it has been purified by washing with bisulphid of carbon. Of the preparations analyzed below, No. I. was formed in a solution containing bromine in excess, and No. II. in a solution containing an excess of sulphid of ethylene.

	Gram.			Gram.		Gram.	
I.	0·4596	substance taken;		0 1840	CO_2	and 0·0705	H_2O found.
"	0·5364	"	"	0·9150	AgBr found.		
II.	0·4776	"	"	0·8140	" "		

		I.	II.	Theory $C_2H_4SBr_2$
C	=	10·92	....	10·91
H	=	1·70	....	1·83
Br	=	72·59	72·53	72·72
S			....	14·54
				100·00

The bromid of sulphid of ethylene is decomposed immediately by water, and also, though less rapidly, by alcohol, with formation of the protoxyd of sulphid of ethylene, together with bromhydric acid. It also absorbs moisture after a short time from the atmosphere, and undergoes the same decomposition; for which reason its purification by washing with bisulphid must be effected as rapidly as possible, and the precipitate must be kept all the time covered with a layer of this liquid.

The bromid is not a very stable body, being decomposed by heat at a temperature considerably under 100° C., and even at the ordinary temperature it is decomposed with disengagement of bromhydric acid, after standing several months in a sealed tube.

It is worthy of remark that the bromid of sulphid of ethylene presents no analogy in its properties with a body having the formula, $C_2H_4SCl_2$, which was obtained by Guthrie by combining directly ethylene gas with the perchlorid of sulphur, (SCl_2).

The purity in which the foregoing compounds are obtained by direct addition of bromine and oxygen to the sulphid of ethylene proves a fact which could not be demonstrated by a simple analysis of the latter, and only with small degree of accuracy by a determination of density of vapor, namely, that this sulphid is a chemically pure compound, and not a mixture of various stages

of condensation of the simple molecule, C_2H_4S; for in case it were composed of such a mixture, the quantity of it which would combine with a given quantity of any element must vary according as one or another of the different stages of condensation predominated in different preparations.

The sulphid of ethylene is isomerous with a crystallized body obtained by the action of sulphuretted hydrogen on aldehyd, and as I at first suspected that the two bodies were identical, I was induced to prepare the latter in order to compare it with the subject of my research. It was obtained from aldehyd by the process of Weidenbusch, and after having been once distilled and separated from its volatile products of decomposition by washing with alcohol, it was repeatedly crystallized from various solvents, but was usually deposited in the form of silky fibres, much too fine for crystallographic determination. Only once, by gradual evaporation of a solution in bisulphid of carbon, were crystals obtained of sufficient size for measurement; they were in the form of long lamellar prisms with well formed faces, which preserved their brilliancy in the air a longer time than the sulphid of ethylene, showing that the substance is less volatile at the ordinary temperature.

According to a determination by Mr. Friedel, the prisms belong to the right rhomboidal system, and have a cleavage parallel to their base. Two parallel faces are much more largely developed than those of the primitive prism, giving to the crystals their lamellar appearance.

Angles measured.		Calculated.
$\infty P : \infty P$	$= 85°$	
$\infty P : \infty P \infty$	$= 137° 40'$	$137° 30'$
$\infty P \infty : OP$	$= 90°$	$90°$

Two systems of rings are apparent when polarized light is passed through a thin piece obtained by cleavage in a direction perpendicular to the plane of cleavage.

The solidifying point of this sulphid is not very distinctly marked; when a delicate thermometer is plunged into a portion which has been melted, the mercury remains stationary an instant at 95° C., while crystalline flakes are seen to form in the melted mass, which then becomes soft and solidifies completely only at 70° C.

When the body is heated in a retort placed in an oil-bath, distillation commences at 205° C., but the point of ebullition rises gradually to 260°, when a partial decomposition takes place and a charred mass is left in the retort.

The sulphid obtained from aldehyd is destroyed by chlorine or bromine with formation of various products. When it is treated with nitric acid, sulphuric acid in notable quantity is formed, but no intermediate product of oxydation, which can be

isolated. It will be thus seen, that this body differs widely in chemical as well as in physical properties from the sulphid of ethylene.

This research was made in the laboratory of Professor Wurtz, to whom I owe my thanks for his kind assistance and valuable suggestions.

Paris, August 11th, 1863.

ART. XXXVIII.—*On the mechanical and chemical treatment of Gold and other metals;* in a letter to Prof. B. SILLIMAN, Jr., from JAMES D. WHELPLEY.

AGREEABLY to your request, I send you herewith a few memoranda in explanation of our new process for preparing quartzose ores of gold for amalgamation.

This process, so far as I am aware, together with all the machinery employed in it, was invented and constructed by Col. J. J. Storer and myself.

Our researches in this direction began in the Spring of 1860 in Philadelphia. We experimented for several months upon a small scale, testing most of the then known processes for reduction and desulphurization of ores. It then appeared to us that processes requiring long periods of time, such as are employed by skillful chemists in the laboratory, could not be applied to large mining operations, where masses of several tons have to be treated at one operation.

A few grains of sulphuret of iron or copper heated to whiteness in a platinum capsule will be thoroughly desulphurized, but a mass of ore weighing several thousands of pounds can not be handled in this manner. The ore fuses in the furnace, taking the form of slag, and holds the sulphur confined in its substance.

If on the other hand the finely pulverized ore be spread thinly over a hearth 14 feet in length and 8 or 10 feet in diameter, with free access of air, and the heat either radiated from the roof or passing up through the hearth of the furnace, a very thorough desulphurization may be effected, by constant turning and exposure of fresh surfaces, taking care that the temperature does not exceed a cherry-red heat.

A large access of atmospheric air is necessary for the management of this process, and it is aided by the addition of chlorid of sodium, and other reducents. Though perfect in the end, it is exceedingly expensive and tedious, because of the care required in regulating temperature and handling of the material.

The results of the experiments with this last process were, however, very valuable to us. We discovered that the first

condition of thorough desulphurization was the reduction of the ores and sulphurets to an *impalpable powder.* The reason of this is evident; viz: that the effect of heat upon a particle increases inversely as the square of its diameter.

Microscopic atoms are readily acted upon by combined air and moisture at a cherry-red heat. Pieces of the size of mustard seed will resist the action of the best managed furnace for hours, and the difficulty increases with the size of the particles directly as the squares of their diameters.

A theoretically perfect process, therefore, requires:—

1st, That every particle shall be microscopically small,—in the condition of fine, floating dust.

2d, That the particles do not touch each other while hot.

3d, That when metallic grains, as of gold or copper, have to be separated from the ore, the contact of water with the heated particles is necessary.

We constructed a furnace in which finely pulverized ore-dust was floated in a current of hot air and flame, passing down through a flue leading from a hard-coal fire, at an angle of about 45°, and then resting upon a horizontal hearth or sole.[1]

We discovered at this time that moisture or the vapor of water in large quantities materially aided the process of desulphurization in free air, and we constructed and applied a steam apparatus by which a volume of steam was made to pass down the inclined flue with the ore-dust, the atmosphere, and the products of combustion.

At this point we encountered several serious difficulties. The inside of the inclined flue became lined with stalactoid masses of semi-fused ores, and the sole of the furnace caked and covered with the same. When a certain quantity of burnt ore had accumulated on the hearth, a trap was opened and the heated mass pushed through into a water-bath. The agglutinated masses, on being withdrawn from the bath, were re-ground, and passed a second time through the furnace.

A sufficiency of atmospheric air could not be applied through the furnace doors, and a very large percentage of the ores escaped through the chimney into the open air.

The last of these difficulties was overcome by placing a powerful fan wheel of copper (which served also as a water or spray wheel) in the chimney itself, or in a chamber of it, and by carrying the horizontal flue some 75 feet beyond this wheel.

The steam from the furnace and the spray from this wheel, working over a pool of water which formed the floor of a horizontal flue, effectually wetted down and saved the flying dust of ore.

[1] This furnace was built and worked in Charlestown, (Mass.) in May, June and July, 1861.—J. D. W.

The brick floor or sole of the furnace was abandoned, and a water-floor substituted. Over one end of this pool or water-hearth, a perpendicular flue was erected, from 12 to 15 feet in height above the surface of the water.

The flames of four fires were poured into the top of this flue by the effect of two fan-wheels: the first, the copper spray-wheel already spoken of; the other, an auxiliary fan blower, sending air into all the fire-boxes. The top of the furnace was left open, and a column of air, bearing pulverized ore, driven directly from the *pulverizing mills*, down through the centre of the perpendicular flue.

The operation of this machinery balanced and regulated the force of the draft so well, that while ore-dust was driven in at the rate of 1200 pounds an hour, carrying with it an excess of atmospheric air, if a side door of the descending flue were opened, a feather would float in the opening without being blown either way.

We then discovered that the immediate quenching of the fused particles of ore, by the water in the pool and in the chamber beyond, was essential to a thorough separation of the metals. The heated particles on touching the surface of the water are exploded into still minuter fragments, a degree of fineness unattainable by any other means. *The entire apparatus is constructed with a view to this result.*

The water lining the bottom of the flues is a circulation completed by an outside canal. The water thrown up from the copper dash wheel, returning circuitously, falls back into the furnace pool. This water, after some time working of the furnace, is of course charged with sulphates of iron, copper, and other metals. The insoluble metal falls to the bottom with the sediment, which is composed chiefly of silica and iron. In this sediment the gold will be found ready for washing and amalgamation.

The sediment is drawn out by the workmen, as fast as it accumulates, through the submerged arches on which the brick flues or water chambers are established.

The condition of the sediment is that of a smooth plasma without grit or coarseness of grain. Using only floating dust, 10 tons can be worked in ten hours with these results, in a furnace of the size indicated. More extensive machinery would give larger returns.

We built our flues and water beds under the furnace and also under the horizontal brick archway leading therefrom to the spray-wheel, of common brick thickly covered with ordinary hydraulic cement. We found this a very good lining for the descending flue or "drop." The spray chamber beyond the dash wheel was built of wood, over a brick and wooden water

channel 75 feet long, 6 feet wide, from 20 to 30 feet high. This was filled with vapor of water and sulphurous acid from the furnace pools, which made a fine rain; carrying down any minute ore-dust which might escape the action of the dash wheel, also condensing large quantities of sulphuric acid from the sulphurets.

The gold ores most free from sulphurets are easily worked. When the sulphur is in excess, the supply of air and moisture must be proportionately large.

In regard to fuel, the finer the ore-dust before burning, the more economical the process.

In places where wood alone is accessible for fuel, the fire-boxes should be from 20 to 30 inches deep, below the fire-bridges; 8 inches for coal.

Crushing machinery.—For crushing gold ores previous to fine grinding, any ordinary crushing machinery may be employed that will reduce them to pea- or gravel-size, as they must not be larger than this before entering the *pulverizer.*

The crushing mill used by us is a patented invention of my own. It consists of a very heavy and solid bar of wrought iron, revolving in the bottom of a cast iron tub as close as possible to the sides and bottom of the tub.

This bar carries at either extremity a hardened steel or chilled-iron plate, with a cutting edge welded to a soft iron back to prevent rupture.

The sides of the tub are pierced with holes from an inch to half an inch in diameter, forming a coarse sieve.

Two of these bars may be used crossed, working *four* cutters, held together by a cast iron center piece of great strength and solidity, through which an upright shaft passes, furnished with a step and a pulley. The speed of these cutters is a little more than 10,000 feet a minute. The broken pieces of quartz are thrown out of the holes in the side of the tub at the rate of *five* tons an hour.

Pulverizing machinery.—The pulverizing of the crushed ore is performed by flat plates of thin iron faced with chilled-iron, attached to radiating arms; somewhat like the paddles of a steamboat wheel. These revolve inside of a cast iron drum, as close as possible to the sides and very near its circumference. A horizontal shaft passes through the centre of the drum.

The material, gravel size, is poured in on one side at the axis by an automatic hopper, which measures the quantity.

A powerful draft of air, forced through the machine by a fan blower forming an essential part of the apparatus, draws out the dust through a hole on the opposite centre of the drum, where the shaft also passes.

The dust is then carried by this fan blower and driven into the top of the furnace. The minimum rate of delivery for a mill of ordinary size is 1500 pounds an hour.

Of this last machine I can not give you a more minute account, as its successful operation depends upon interior details, obtained by long and costly experiment. The maximum rate of production we have not yet ascertained.

All the new and important features have been patented by Col. J. J. Storer and myself.

As soon as possible, I will furnish you with working plans of the furnaces built and worked by us. We have ground the hardest copper ores of Vermont and the quartz of Nova Scotia in our pulverizing mills. I know of none more difficult of reduction.

Boston, Mass., March 5th, 1864.

Art. XXXIX.—*Mineralogical Notices;* by Charles Upham Shepard, of Amherst College.

Ores of Antimony.—This metal is rather recently made known to us as entering into the mineral wealth of this continent. The antimonite has been reported from a place called Soldier's Delight, in Md.; and from Carmel, in Penobscot Co., Me. About fifteen years ago, very distinct specimens, though in small quantity, were brought to me from Cornish, N. H., by Prof. F. Shepherd. The Breithauptite has for several years been known as existing at the Chatham (Conn.) nickel mine. But at neither of these localities was there any flattering promise of the metal in workable quantity. It now, however, promises to be produced from more than one American locality. Beside the South Ham, C. E., mines of *antimony*, of which a notice is here submitted from C. H. Hitchcock, Esq., as the result of a very recent survey, we find mention made of two other localities in his second report on the geology of the State of Maine (1863), one of these being in the Province of New Brunswick and the other in the eastern part of Maine.

Mr. Hitchcock, in presenting me with his notice of the South Ham mines, submitted also several other ores of antimony unknown on this continent before the discovery of this mine, a description of which I append to his account.

Mr. Hitchcock's Statement on the Antimony Mine of South Ham, C. E.—The rocks are the common talco-micaceous schists of the Quebec Group of the Lower Silurian. The strata run N. 55°

E., and dip at a high angle N. 35° W. There are three metallic lodes upon the hill cutting across the strata at various angles, and all intersecting with one another so as to form a triangular space. I have seen but one other example of a cross lode in Canada.

A trial shaft has been sunk upon one of the veins, and at a depth of 15 feet shows an increase of the lode from 18 inches to three feet, with very distinct walls. This lode has been traced with the course E. 15° N. for a distance of half a mile. The two other lodes are a very little smaller, and have the courses N.E. and W. 28° S. The intersections of the veins have not been exposed. The dip is variable, the first and second dipping toward each other.

West of the lodes and higher up the hill is a small bed of serpentine. I have not been able to trace either lode across it, and suspect the serpentine has cut off the lodes, as the gangue of the lodes appears on the west side of the former. Numerous small leaders to the main lodes traverse the schists, and are all charged with antimony.

The gangue is mostly a quartz rock of a dark bluish tint. The metal is disseminated through it generally unostentatiously, but occasionally in both large and small lumps. Dr. Hayes's assays for the proprietors show that very unpromising portions of the gangue yield 80 per cent of antimony. The richest portions of the lode vary in position, sometimes on the foot and sometimes on the hanging wall. The native metal is the common form of the occurrence of the antimony. The ores occur only occasionally, and not in workable quantities. A company has been formed to work the lodes, with flattering prospects of success. The mine is about thirty miles distant from either Danville or Athabaska stations on the Quebec branch of the Grand Trunk Railway. C. H. HITCHCOCK.

The new ores are stiblite, senarmontite and kermesite.[1]

[1] The following account of the antimony mine of South Ham, C. E., is published in the Report on the Geological Survey of Canada, by Sir Wm. E. Logan (1863), as a note to page 876, from which it appears that Professor Shepard's observations are here mostly anticipated:

"A deposit of this metal has lately been discovered in the township of South Ham, on the twenty-eighth lot of the range east of the Gosford road. It is described as occurring in a vein or bed, of from six to sixteen inches in thickness, in argillite, which is penetrated by numerous smaller veins of the ore. The greater portion of the antimony is in the metallic state, as lamellar, or more rarely, as finely granular native antimony; but the sulphuret, antimony glance, also occurs in small radiating prismatic crystallizations. Besides these, the white oxyd of antimony, both massive and fibrous, is found in this locality, associated with small crystalline tufts of the red oxysulphuret of antimony, kermesite. These latter ores are probably only the results of superficial oxydation. From the specimens already obtained from this locality, it would appear probable that antimony exists here in workable quantity. It is accompanied by quartz and a little brown-spar."—EDS.

1. *Stiblite.*—This occurs in crusts upon antimony and quartz, and in pseudomorphs after antimonite, the remains of whose crystals may generally be seen occupying the centres of the pseudomorphs. They are opaque, of a pale ochre-yellow color, and possessed of a glimmering lustre. In a closed tube they yield water; before the blowpipe are not reduced, but form a stain on charcoal.

2. *Senarmontite.*—This exists in small, nearly transparent, octahedral crystals. Before the blowpipe, melts easily; on charcoal, forms a thick white coating; and in the reducing flame gives metallic antimony. In the closed tube it wholly sublimes. It dissolves readily in chlorhydric acid, the solution yielding a white precipitate on dilution with water.

3. *Kermesite.*—Occurs in minute acicular crystals and in compact bundles of diverging fibres. Color cherry-red. Before the blowpipe, melts; depositing a sublimate of antimonious acid. Soluble in chlorhydric acid with extrication of sulphuretted hydrogen. When treated in powder with caustic potassa, its color changes to yellow, after which it is taken into solution.

Eudialyte in Arkansas.—I found this mineral in 1861 at Magnet Cove, in imperfect rounded crystals, imbedded in feldspar, and associated with ægirine, the three belonging to the extensive elæolitic rock of that remarkable region. At first, I took it for corundum,—its color being a rich crimson, varying to peach-blossom red. Its hardness, however, was discovered to be rather under 6. Before the blowpipe it melted into a greenish scoria, and when in powder promptly gelatinized in chlorhydric acid.

Ægirine also occurs at the same locality in loose crystals in the soil.

Tungsten at Chesterfield, Ms.—A specimen of this tin-accompanying species has for some years been in my collection, coming from the celebrated green and red tourmaline vein of Chesterfield. It is imbedded in albite and associated with tourmalines. It was in close proximity to minute crystals of cassiterite, a species now frequently found in the granite of the adjoining towns of Goshen and Norwich.

Amherst, Jan. 7, 1864.

SCIENTIFIC INTELLIGENCE.

I. PHYSICS AND CHEMISTRY.

1. *On the spectrum of carbon.*—ATTFIELD has examined the spectrum of carbon as observed in various flames containing this element, and in the light of the electric spark passed through dilute carbonic oxyd and bisulphid of carbon. Swan observed in 1856 that all hydrocarbon flames give four groups of rays, which are respectively faint yellow, light green, bright blue, and rich violet. The author concluded that these bands must arise from incandescent carbon vapor. The spectrum of a mixture of coal gas and oxygen was brilliant and well defined. The yellow-green band was found to consist of six lines; the green band of five; the blue of five, and the violet band of two with a faint hair line between. The spectrum of cyanogen gave—as stated long since by Draper—a splendid series of bands which became still more distinct and brilliant on feeding the flame with oxygen. By direct comparison it was easily shown that the cyanogen spectrum contains the same lines as that of coal gas, together with a very distinct and complex nitrogen spectrum. Rarefied cyanogen gave precisely the same spectrum on passing electric discharges through the tube. A tube containing a trace of olefiant gas gave a spectrum identical with that of a hydrocarbon burning in air. The flames of carbonic oxyd and bisulphid of carbon give continuous spectra, but when small quantities are ignited in tubes by the electric discharge, brilliant and sharp spectra are obtained which exhibit the four groups of bands above described. The author concludes that these bands form the spectrum of carbon, and as the blue band is the brightest, he explains in this manner the blue color of many flames. The "blue heat" of a Deville's furnace is doubtless a case in point.—*Journal of Chem. Soc.*, [2], i, 97. W. G.

2. *On the optical distinction between hypermanganic acid and compounds of sesquioxyd of manganese.*—HOPPE-SEYLER has found that a solution of hypermanganic acid exerts a powerful absorption upon green and green-yellow rays. A solution of phosphate of sesquioxyd of manganese exhibits the same action. If, however, the solution of this salt is diluted more and more, the absorption in the middle of the spectrum gradually disappears without the appearance of definite bands, while dilute solutions of hypermanganic acid exhibit five distinct absorption bands, of which the first, reckoning from the red, lies beyond D, the second dark band between C and *b* (sic), the third, also very dark, upon E extending to *b*, the fourth between *b* and F, and the fifth and weakest upon F. Sesquichlorid and sulphate of sesquioxyd of manganese exhibit the same action as the phosphate, except that there is here an absorption also in the blue and violet. The solution obtained by Crum's test exhibited the five absorption bands very clearly. Hence it appears that Rose was in error in considering this solution to contain sesquioxyd.—*Journal für prakt. Chemie*, xc, 303.

3. *On the action of light upon nitro-prussid of sodium.*—ROUSSIN has proposed a method of determining the chemical intensity of light which is based upon the decomposition produced in a solution of nitro-prussid

of sodium mixed with sesquichlorid of iron. The author recommends a solution containing two parts of this nitro-prussid, two of dry sesquichlorid of iron, and ten of water. The solution is to be filtered and kept in a bottle covered with black paper. An exposure of a few minutes to solar light is sufficient to communicate to this liquid an intense blue tint with an abundant precipitate of prussian blue. The author proposes to measure the chemical intensity of light by determining the density of the normal solution by means of an areometer before and after insolation, the temperature being in each case supposed to be the same. It seems not impossible that this process may contain the germ of a valuable method of investigation, but no experimental data are given by which to judge of its value.—*Les Mondes*, March, 1864, 415. W. G.

4. *On the barometer, as an indicator of the earth's rotation, and the sun's distance;*[1] by PLINY EARLE CHASE.—The existence of daily barometric tides has been known for more than a hundred and fifty years, but their cause is still a matter of dispute. It is evident that they cannot be accounted for by variations of temperature, for, 1, their regularity is not perceived until all the *known* effects of temperature have been eliminated; 2, they occur in all climates, and at all seasons; 3, opposite effects are produced at different times, under the same average temperature. Thus at St. Helena, the mean of three years' hourly observation gives the following average barometric heights:

From 0^h to 12^h 28·2801 in.	From 18^h to 6^h 28·2838 in.
" 12^h to 0^h 28·2861 "	" 6^h to 18^h 28·2784 "

The upper lines evidently embrace the coolest parts of the day, and the lower lines the warmest. Dividing the day in the first method, the barometer is highest when the thermometer is highest; but in the second division the high barometer prevails during the coolest half of the day.

On account of the combined effects of the earth's rotation and revolution, each particle of air has a velocity in the direction of its orbit, varying at the equator from about 65,000 miles per hour, at noon, to 67,000 miles per hour, at midnight. The force of rotation may be readily compared with that of gravity by observing the effects produced by each in twenty-four hours, the interval that elapses between two successive returns of any point to the same relative position with the sun. The force of rotation producing a daily motion of 24,895 miles, and the force of terrestrial gravity a motion of 22,738,900 miles, the ratio of the former to the latter is $\frac{24895}{22738900}$, or ·00109. This ratio represents the proportionate elevation or depression of the barometer above or below its mean height that should be caused by the earth's rotation, and it corresponds very nearly with the actual disturbance at stations near the equator.

From 0h. to 6h. the air has a forward motion greater than that of the earth, so that it tends to fly away; its pressure is therefore diminished, and the mercury falls. From 6h. to 12h. the earth's motion is greatest; it therefore presses against the lagging air, and the barometer rises. From 12h. to 18h. the earth moves away from the air, and the barometer falls; while from 18h. to 24h. the increasing velocity of the air urges it against the earth, and the barometer rises.

[1] From the Proceedings of the American Philosophical Society.

If the force of rotation at each instant be resolved into two components, one in the direction of the radius vector, and the other parallel to the earth's orbit, it will be readily perceived that whenever the latter tends to increase the aerial pressure, the former tends to diminish it, and vice versa. Let B = the height of the barometer at any given instant; M = the mean height at the place of observation; $\theta - 90°$ = the hour angle; C = the earth's circumference at the equator; t = 24 hours; g = the terrestrial gravity; l = the latitude: and a simple integration gives the theoretical formula, $B = M\left(1 + \frac{\sin\theta\cos\theta\cos l}{R^2} \cdot \frac{2C}{gt^2}\right)$.*

This formula gives a maximum height at 9h. and 21h. and a minimum at 3h. and 15h. The St. Helena observations place the maximum at 10h. and 22h. and the minimum at 4h. and 16h.: an hour later in each instance than the theoretical time. This is the precise amount of retardation caused by the inertia of the mercury, as indicated by the comparisons with the water barometer of the Royal Society of London.

Aerial currents, variations of temperature, moisture, and centrifugal force, solar and lunar attraction, the obliquity of the ecliptic, and various other disturbing causes, produce, as might be naturally expected, great differences between the results of theory and observation. But by taking the grand mean of a series of observations, sufficiently extended to balance and eliminate the principal opposing inequalities, the two results present a wonderful coincidence.

According to our formula, the differences of altitude at 1, 2, and 3 hours from the mean, should be in the respective ratios of ·5, ·866, and 1. The actual differences, according to the mean of the St. Helena observations, are as follows:

	Differences of Barometer.			Ratios.		
Diff. of time,	1h.	2h.	3h.	1h.	2h.	3h.
Before 1h,	·0166	·0298	·0365	·455	·816	1
After "	·0159	·0266	·0298	·534	·893	1
Before 7h.	·0122	·0202	·0243	·502	·831	1
After "	·0135	·0239	.0297	·455	·805	1
Before 13h.	·0136	·0248	·0284	·479	·873	1
After "	·0131	·0215	·0227	·577	·947	1
Before 19h.	·0161	·0287	·0348	·463	·825	1
After "	·0150	·0265	·0286	·524	·927	1
Mean	·0145	·0252	·0293	·495	·860	1

The mean of the above differences varies from the theoretical mean less than $\frac{1}{5000}$ of an inch. If we take the mean of the ratios, instead of the ratios of the means of the observed differences, the coincidence is still more striking.

Difference of Time,	1h.	2h.	3h.
Means of Observed ratios,	·498625	·864625	1·000000
Theoretical Means,	·500000	·866025	1·000000

* $\frac{C}{gt^2}$ represents the effective ratio of an entire day. But there is in each day a half day of acceleration, and a half day of retardation, and the ratio for each half day is $\frac{C}{2} \div \frac{gt^2}{4} = \frac{2C}{gt^2}$.

The calculated time for the above observed means differs less than 20″ from the actual time.

Observed Means,	·498625	·864625	1·000000
Theoret. Diff. of Time,	59′ 48″	119′ 40″	180′
Observed " " "	60′ 0″	120′ 0″	180′

The varying centrifugal force to which the earth is subjected by the ellipticity of its orbit, must, in like manner, produce annual tides. The disturbing elements render it impossible to determine the average monthly height of the barometer, with any degree of accuracy, from any observations that have hitherto been made. We may, however, make an interesting approximation to the annual range, still using the St. Helena records, which are the most complete that have yet been published for any station near the equator. Comparing the mean daily range, as determined by the average of the observations at each hour, with the mean yearly range, as determined by the monthly averages, we obtain the following results:

Year.	Daily range.	Annual range.	Ratio.	Approximate Solar distance.
1844	·0672 in.	·1650 in.	2·4553	137,070,000 m.
1845	·0646 "	·1214 "	1·8793	80,300,000 "
1846	·0670 "	·1214 "	1·8120	74,650,000 "
	3)·1988	3)·4078	3)6·1466	
	·0663	·1359	2·0489	95,446,000 "
Mean	·0663	·1290	1·9457	86,056,000 "
	2)·1326	2)·2649	2)3·9946	
	·0663	·1324	1·9973	90,702,000 "

The approximate estimates of the solar distance are based on the following hypothesis:

Let e = effective ratio of daily rotation to gravity.
a = arc described by force of rotation in a given time t.
r = radius of relative sphere of attraction, or distance through which a body would fall by gravity, during the disturbance of its equilibrium by rotation.
A = area described by radius vector in time t.

Let e', a', r', A$'$, represent corresponding elements of the annual revolution. Then,

$$A : A' :: ar : a'\,r' :: e^2 : e'^2$$

But the forces of rotation and revolution are so connected, that a differs but slightly from a'.

$$\therefore \left.\begin{array}{l} e^2 : e'^2 :: r : r' \\ r' = \dfrac{e'^2 r}{e^2} \end{array}\right\} \text{very nearly.}$$

It may be interesting to observe how nearly r (22,738,900 m.) corresponds with Kirkwood's value of $\frac{D}{2}$(24,932,000 m.). A more thorough comprehension of all the various effects of gravity and rotation on the atmosphere, would probably lead to modifications of our formulæ that would show a still closer correspondence.

There is a great discrepancy between the determinations of the solar distance that are based on the records of 1844 and 1846; but it is no greater than we might reasonably have anticipated. On the other hand, it could hardly have been expected that any comparisons based on the observations of so short a period as three years, would have furnished so near an approximation to the most recent and most accurate determination of the earth's mean radius vector. In order to obtain that approximation, it will be seen that I took, 1st, the mean of the ranges and ratios for the three successive years; 2d, the ranges and ratios of the mean results of the three years; 3d, the grand mean of these two primary means. I could think of no other method which would be so likely to destroy the effects of changing seasons, and other accidental disturbances.

The following table exhibits the effects of latitude on the aerobaric tides. The differences between the theoretical and observed ranges may be owing partly to the equatorial-polar currents, and partly to insufficient observations.

Station.	Lat.	Mean height.	Mean range.	Ratio.	Theoret. ratio.
Arctic Ocean,	78° 37′	29·739 in.	·012 in.	·000404	·000527
Girard College,	39 58	29·938	·060	·002004	·002046
Washington,	38 53	30·020	·062	·002065	·002079
St. Helena,	15 57	28·282	·066	·002344	·002567
Equator,	0	30·709	·082	·002670	·002670

The theoretical ratios are determined by multiplying the equatorial ratios by $\frac{\cos l}{R}$. The formula, $\rho = \frac{\cos l}{R} \cdot \frac{2C}{gt^2}$, ($\rho$ indicating the ratio of the mean range to the mean height,) gives:

	Theoretical Ratio.	Observed Ratio.
Latitude, 0°	·002190	·002670
" 78 37′	·000432	·000404

showing that the ratio is less near the pole and greater near the equator than our theory indicates, a natural consequence of the centrifugal force at the equator and the cold surface currents that produce the trade winds.

The revolution of the sun around the great Central Sun must also cause barometric fluctuations that may possibly be measured by delicate instruments and long and patient observation. The Toricellian column may thus become a valuable auxiliary in verifying or rectifying our estimates of the distances and masses of the principal heavenly bodies.

5. *On the equivalent of tungsten.*—Persoz has published an extended memoir on tungsten and its compounds, and has arrived at conclusions which differ very widely from those received by chemists. These conclusions, in the author's own words, are as follows:

(1.) Tungsten, according to the constitution and properties of its oxyds, belongs to the group of biatomic (sic) radicals, arsenic, antimony, and phosphorus.

(2.) Its equivalent (O=100) deduced from numerous experiments is 1916. (Or 153·2 if O=8.)

(3.) Tungsten forms two compounds with oxygen:

a. An oxyd WO_3, tungstic oxyd.

b. An acid WO_5, tungstic acid.

(4.) By their union these two compounds may produce a third oxyd (of the class of saline oxyds of Dumas) which corresponds to the formula

$$WO_3+WO_5=2WO_4.$$

(5.) Tungstic acid is polybasic; its simple or double salts are represented by the general formulas

$$WO_5 . MO, HO+nAq$$
$$WO_5 . MO, MO+nAq.$$

(6.) Tungstic acid may, like its congeners, phosphoric and antimonic acids, be physically modified by heat, so that its capacity of saturation is reduced one half. We may then say that it gives rise to a new acid, metatungstic acid, whose existence depends besides on well determined conditions. The formula of this acid is $(WO_5)_2$ or W_2O_{10}.

(7.) The simple metatungstates are represented by the formula

$$(WO_5)_2MO, HO+Aq.$$

They easily form double salts by uniting, either with each other:

a. $$\left.\begin{matrix}(WO_5)_2MO, HO\\(WO_5)_2MO, HO\end{matrix}\right\}+Aq.$$

b. or with simple tungstates,

$$\left.\begin{matrix}(WO_5)_2MO, HO\\WO_5 . MO, HO\end{matrix}\right\}+Aq.$$

The formulas comprise the paratungstates and certain acid tungstates.

(8.) Sulphur, chlorine, and bromine combine with tungsten, producing compounds which correspond exactly to the oxyds and acids formed with oxygen.

(9.) Tungsten does not produce an oxychlorid any more than phosphorus. The compounds which have been so designated are combinations in definite but variable proportions of anhydrous acid with the corresponding chlorid.—*Ann. der Chimie et de Physique*, Jan. 1864, 93.

W. G.

6. *On Mauve or Anilin purple.*—PERKIN has discovered in anilin purple a new organic base, to which he has given the name Mauveine. The new base is a black glistening crystalline body not unlike pulverized specular iron ore. Mauveine dissolves in alcohol, giving a violet solution which assumes a purple color on the addition of acids. It is a very stable body and readily decomposes ammoniacal salts; when heated strongly it yields a basic oil. The formula of mauveine is $C_{54}H_{24}N_4$; it appears to be a tetrammine. When heated with anilin, mauveine yields a blue coloring matter now under investigation. The chlorhydrate of mauveine is formed by the direct combination of its elements, and is deposited from a boiling alcoholic solution in small prisms possessing a brilliant green metallic lustre. Its formula is $C_{54}H_{24}N_4, HCl$. This salt combines with bichlorid of platinum to form a beautiful crystalline compound, the formula of which is $C_{54}H_{24}N_4, HCl+PtCl_2$. The author describes several other crystalline salts, which serve to prove the correctness of the formula adopted.—*Proc. of the Royal Society*, xii, 713.

W. G.

7. *On Crystals in Blowpipe Beads*; by GEORGE H. EMERSON.—Observations which I have made during the past year on the opacity produced by "flaming" in beads of borax, or microcosmic salt, when charged with certain substances, have established the fact that this opacity is due to the presence of crystals of a definite form, which varies with the substance employed; and, also, that the same substance, in some cases, gives a different crystalline form with the different fluxes. The crystals are generally so minute as to require a good hand-lens, or even a compound microscope, to examine them advantageously; and, in order to facilitate microscopic examination, the loop of platinum wire should be at least a tenth of an inch in diameter, and quite circular, and the bead very slightly convex.

A little practice will enable the operator to regulate the density of the opacity—a very thin film, or cloud, extending partially over the surface of the bead, being all that is desirable. I have found it convenient to use a small, fine-pointed flame, briefly exposing a portion of the glass to the reheating, or "flaming," process.

Examination of the precipitates—if I may so term the slight films thus obtained on, or near, the surface of the glass—has disclosed crystals varying in form and other characters according to the substance treated; but, so far as my observations have extended, the characteristics of any given substance are constant, the same flux being employed, and they are generally sufficiently well marked to serve as reaction for the substance in question.

I have, thus far, obtained crystals with *baryta*, *strontia*, *lime*, *magnesia*, *alumina*, *glucina*, *zirconia*, *zinc*, *cadmium*, *bismuth*, *silver*, *tin*, *tungstic acid*, *molybdic acid*, *protoxyd of cerium*, *selenium* and *tellurium*.

With *copper* and *uranium* I have noticed what seems to be a crystalline precipitate; and the *titanic* and *niobic acid* precipitates possess distinct characters, although they do not appear to be crystalline.

While pursuing this investigation, I have been led to notice that the small fine-pointed flame I have referred to, when acting momentarily on a small part only of the bead, possesses a very powerful reducing influence, if the inner flame alone be allowed to affect the glass. In this way I have obtained a gray, metallic precipitate on the reheated portion of the surface of a borax bead, colored dark blue with oxyd of cobalt; and, similarly treated, there is a metallic precipitate with molybdic acid. In this connection it should be understood, that charcoal is not employed, but the substance is simply fused with borax, in the outer flame, on platinum wire, the glass allowed to cool, and then treated as just described, without being removed from the wire.

Most of the substances enumerated give characters easily recognized when magnified forty or fifty diameters, and sometimes even with the naked eye; but it is occasionally necessary to employ a magnifying power of one hundred and fifty diameters, or even more—to clearly distinguish the titanic from the niobic acid precipitate, for example. With the aid of the microscope, the precipitate will frequently indicate with considerable certainty the presence of two substances, so that they may both be recognized, as may be seen in beads charged with mixtures of tungstic and titanic, and tungstic and niobic acids.

I would refer those who may desire a more extended account of this method of blowpipe analysis, including particular descriptions of all, and engravings of some, of the precipitates observed, to a paper entitled "Observations on Crystals and Precipitates in Blowpipe Beads," to appear in the forthcoming "Memoirs" of the "Boston Society of Natural History."

Cambridge, February, 1864.

7. *Elements of Chemistry: Theoretical and Practical;* by WILLIAM ALLEN MILLER, M.D., L.L.D., Professor of Chemistry in King's College, London, &c., &c. Chemical Physics, Part II: Electricity and Magnetism. From the third London edition. New York: John Wiley, 535 Broadway, 1864. pp. 190, 8vo.—In furnishing a handsome reprint of the third edition of this valuable handbook, Mr. Wiley confers a great favor upon the American public which we trust will be suitably appreciated. Prof. Miller's work is beyond all comparison the best in the English language, and, we may add, the best in any language, for the general purposes of the higher student of chemical philosophy.

The reprint is begun with part third of vol. I. to accommodate the West Point Academy. The other parts of this volume may be expected shortly, and the other (as yet unfinished) volumes will be issued soon after their completion. S. W. J.

II. MINERALOGY AND GEOLOGY.

1. *Volcano of Kilauea, Hawaii.*—I. From a letter to Prof. LYMAN, from Rev. T. COAN, dated Oct. 6, 1863.—Kilauea has been quite active during most of the summer. Several new cones have been thrown up, from which steam and boiling lava have issued with violent hissings and detonations. The lavas have burst up at several points, and the great molten lake has risen and thrown its fiery jets far over its rim, sometimes shooting them upward 40 to 100 feet. The upward pressure of the lava has opened seams in some parts of the crater, from which it has flowed out and covered extended areas. The rim of the cauldron has also been rent on its lower side, and floods of molten rock have there been disgorged.

The whole circumference of the crater under its surrounding walls has been submerged beneath molten lava, and some portions of it several times. By this circumference, or outer belt, I mean the limits of the so-called "Black Ledge." Of course, there is no Black Ledge there now, it having been overflowed and obliterated more than 10 years ago. All the northern portion of the crater, in the region where the foot-path descending from the huts terminates upon the black "pahoehoe," or solid lava of the interior, has been raised 70 to 100 feet by successive floodings from other portions of the crater, especially from the regions near "Halemaumau," or the great lake of lava.

At times it has been reported by visitors to be impossible to descend and reach, by the usual path, the floor of the crater, on account of the sea of fire at its terminus. Immense floods of lava have been deposited and cooled all along the high bluff off toward Kau, and several lakes have opened at times in that locality. I think your last measurement of that wall made it about 700 feet; probably it is not more than 600 feet now.

The central area remains undisturbed, except that it is greatly elevated by the lifting forces beneath. It is quite a distinct table-land, probably 500 to 600 feet higher than it was just after the great tapping process of 1840.

Mauna Loa is quiet, and we have no symptoms of disturbance except at Kilauea. We are looking for some grand demonstration in the latter: —the time we do not predict.

[In order to make the preceding account, and also the following, intelligible to readers that are not familiar with the crater of Kilauea, we add a few explanations, although but a repetition of what has appeared in this Journal. The operations described above are confined to the *bottom* of the great pit-crater, called Kilauea, or Lua Pele. The pit is surrounded through the greater part of its circuit by nearly vertical walls of solid lava, looking like stratified rocks in the distance, and having now, as stated by Mr. Coan, a height on the west side of only about 600 feet. In the southwest part of the solid lava plain which constitutes the bottom of the crater, there is the great lake of lava, called "Halemaumau," forming the center generally of a low cone. The usual path for descending into the crater of Kilauea is in the northeast corner. After the eruption of 1840, the central portions of the pit, having an area one-third of the whole, sank 300 to 400 feet below the circumferential portion, so that the crater over this part was 1000 feet deep. The circumferential portion, forming a border-plain or terrace around the lower pit, is the part called the "black ledge." Within ten years after 1840, the lower pit had become filled up through the overflowings of lava over its bottom, so that the limits of the "black ledge" were already mostly obliterated. No great eruption has since taken place.—J. D. D.]

II. From a letter from Rev. O. H. Gulick, Missionary of the American Board, residing at Kau, on the Island of Hawaii, dated Kau, July 25th, 1863, cited from the Evangelist.—We found the crater very active. About a thousand acres—or say one-sixth of the area of the bed of the crater—has been covered with late eruptions of *pahoehoe* (smooth lava) which have taken place within six or eight weeks. These eruptions have occurred on the north side of the crater, perhaps two or three miles from the great lake. This late eruption is still warm, and in some places hot, with fire glowing in the deeper cracks. That part of the bed of the crater upon which we first tread on completing the descent from the house, was fresh and still warm to the feet, though perhaps six weeks old.

Crossing this late flow, which in this spot was but thirty or forty rods in width, we proceeded directly to the great lake, three miles distant, in the south side of the crater. The lake, which is continually varying in size and form, we found to be perhaps four hundred and fifty feet in diameter, and twenty feet below the surrounding bank, and exceedingly active.

I have visited the crater but once before this, and that was in 1846 or 1847. The lake was then *elevated* above the general floor of the crater, and appeared to be enclosed by a stone wall. While we were approaching it, the surging lava broke through the stone wall and ran out toward us, and we were able to approach the flow and take out specimens on the ends of our long walking-sticks. *This time* we saw the

lake as travellers have spoken of it for years past. It is not often, however, I think, that it has been found more active. Different caverns at the side of the lake were continually spouting forth their fiery foam, while waves of liquid fire occasionally broke upon the rocky banks like a returning tidal wave upon old Ocean's shore. At intervals, sometimes of a few seconds, and at other times of half a minute, a large fountain broke forth in the middle of the lake and threw up its rounded crest of red lava ten or twelve feet, while smaller masses of lava and spray were thrown up twenty or thirty feet. The whole lake, except in the spot of active ebullition, was covered with a tough crust or scum of a pale leaden color, resembling the skin that forms on the surface of a pot of liquid lead or iron. This crust was in continual motion, being drawn in from different directions towards the centres of ebullition; as it entered the foaming mass, or the fiery fountains, it was at once consumed and resolved into molten lava. Ever-changing scenes of fire were visible in the different portions of this crust, which floated like thin cream on the surface. Small stones thrown in sank partially through this skin as if into mud. The appearance of the fiery fountains throwing up their lurid wave eight, ten, or twelve feet, and sending their spray to a height far above, was awfully and indescribably grand.

The scene was ever changing; first the greatest display of fireworks, fountains spraying and jetting, would be in one quarter of the lake; then in another; then in three, four, or five different points, all at once. At irregular intervals of a minute or two, a small cone of twelve or fifteen feet in height, and removed some forty feet from the lake, utters the most unearthly roaring and snorting, as if from ten thousand demons confined below. These sounds, as well as the jettings and spoutings, seemed to be caused by the escaping of steam and gases from below.

We wandered about for an hour and a half and then returned to our lodgings—four miles distant, on the brink of the vast crater.

At ten o'clock at night we were called from our slumbers by the shout of a fellow-traveller. Springing to the door we beheld a new eruption that had that moment burst forth on the ground of the late flows in that part of the floor of the crater which we struck on our first descent into the crater, and nearly two and a-half miles from the great lake. This eruption played for hours like a fountain, fully thirty feet high. We saw the streams of fire, fed by the fountain, coursing down many rods from their source. The next morning it had subsided. A few acres covered by the glistening lava was all that the morning showed of that night's work of Modern Pele.

Such a sight travellers to Kilauea are permitted to behold. The volcano is more active than it has been for years. There are occasional slight earthquakes throughout Hawaii.

2. *On Glacial Phenomena in Nova Scotia;* by B. SILLIMAN, Jr. (From a Report on the Gold property of the New York and Nova Scotia Gold Mining Company. 56 pp., 8vo, 1864.)—The most striking physical feature of this whole region, to the eye of a geologist, next perhaps to the uptilted state of the slaty rocks, is the universal evidence of a high degree of glacial action, which has so worn down and polished the rocks that their edges everywhere resemble the leaves of a book which has

been cut with a dull knife in the binder's press, in a direction at right angles to that of the leaves.

Over very considerable areas, the glacial scouring has been so thorough that nothing whatever is left on the rocks but the grooves and striæ which accompany their polish. In other cases, the glacial drift is seen, composed of angular, rarely rounded, fragments of quartzite and clay slate, imbedded in a tough clay, resting on the surface of the polished rocks. This detrital matter is auriferous, but the large amount of coarse, angular fragments of rocks would render it very difficult to wash, even when it occurs in situations where water could be conveniently obtained for sluicing. The gold which it contains is coarse and angular, often still attached to the quartz, and showing but little evidence of long transportation. The "Boulder Lot," at Sherbrooke, has yielded a considerable amount of gold from this glacial drift, and is rewarding its owners handsomely. Probably too little attention has been given in the Province to this source of gold. The quartz veins alone having been the chief object of attention.

Everywhere over this whole district the eye of the observer is constantly arrested by the long lines of granitic and quartzitic boulders, which have been left in trains by the ancient glaciers upon the surface of the polished rocks. These at times recall strongly the moraines of the Swiss glaciers, and rival them in the magnitude of the travelled blocks. Some of the most striking cases of this sort which I saw were in the vicinity of Musquodobit Harbor, also on the flanks of the Musquodobit Mountains, and on the elevated plateau between Jeddore Bay and Ship Harbor, known as the Barrens. Here the boulders of white quartz are also very abundant. Some very conspicuous blocks of a like character occur also on the hills north of Oldham, in the vicinity of Gay's River.

The general course of the strike of the rocks is east and west. Between Hammond Plains and Tangier, for a distance of nearly 100 miles, this east and west course is so marked that it may be considered universal. This course is not usually over 5° or 6° away from the magnetic meridian, and is usually south by that quantity. But to the east and west of the points named, the strata bend round to the sea, so that the whole system assumes very much the form of a long bow, whose chord or string is the coast line, the strata at each end losing themselves in the ocean.

Consequently, for a great part of the whole coast, the glacial scratches, or the course of the glacial drift, has been almost at right angles to the strike of the rocks. A most conspicuous example of this may be seen at the Round Tower, near Halifax, where a large surface of the harder slates is completely denuded, and shows splendidly the whole phenomena of glacial action. These facts bear in a most important manner, it will be seen, upon the occurrence of the gold. They account in fact, for the general absence of alluvial gold.

If we consider for a moment the physical and geological features just described, it at once becomes evident that the great mass of loose materials which came from the scouring off of the country by glacial action, has gone into the Atlantic Ocean, where the gold is safely deposited. Sable Island, which, by McKinley's map, is distant about 100 miles from

the shore, is a sand spit, 30 miles long by about half a mile wide, shaped like a bow, and consists entirely of an accumulation of loose white sands. Mr. Campbell, the Provincial Geologist, informs me that he washed gold from these sands in 1857, and that it was in very small, highly polished scales, like the fine gold of California. That it came with the sands which proceeded from the scouring off of Nova Scotia, no geologist can doubt for a moment. It follows from this view of the case, that the occurrence of extensive "diggings" in Nova Scotia is a thing not to be expected. No long Sacramento Valley has retained here the spoils of the glacial epoch; and this fact appears to have been practically recognized from the outset, as comparatively few efforts have been made to obtain gold from any source but from the quartz veins.

The success following the washing of the sands near Lunenburg was, however, encouraging, and there are doubtless places of considerable extent in the numerous harbors and bays of the coast, where auriferous sands exist in remunerative abundance. The bottoms of some lakes, which can be drained, will probably furnish considerable deposits of alluvial gold; and the same is true, no doubt, of certain river estuaries and marsh lands which have hitherto attracted too little attention; such, probably, are the flats bordering on Chedabucto Bay.

3. *Synopsis of the Flora of the Carboniferous Period in Nova Scotia;* by J. W. Dawson, LL. D., F.R.S., F.G.S., &c., Principal of McGill College. (Condensed from the Canadian Naturalist.)—The following list includes the plants in the collection of the writer, and in collections submitted to him by several geological friends; as well as those previously catalogued by Mr. Bunbury, in Sir Charles Lyell's Travels, and in the Journal of the Geological Society, and by Mr. R. Brown and the author, in the list appended to "Acadian Geology."

The present synopsis was prepared not so much for immediate publication, as in aid of the writer's investigations of the characteristic plants in the numerous coal beds at the South Joggins, and of the conditions of formation of those beds; but as some time may elapse before the publication of these researches, and the want of a list of the known species is much felt by those engaged in the study of the Carboniferous rocks, it has been thought advisable to print it in the present form.

The new species have been described in the *Canadian Naturalist and Geologist*, for Dec. 1863, with mention of their collectors and localities. The part of the Carboniferous system in which the species occur has, however, been stated; and as some confusion has lately arisen from the use of the term "Subcarboniferous," by authors, it is proper to state that the name "*Lower coal formation*" in this paper is equivalent to "Subcarboniferous" of Dana; that "*Middle coal formation*" denotes that part of the system over the Marine Limestones and holding the principal coal beds; and that "*Upper coal formation*" is applied to the newer part of the system over the productive coal measures.[1] These three members are, to a certain extent, distinct in their flora. Any minor differences which exist, in subordination to these main divisions, will be fully detailed in the memoir on the coal beds of the Joggins already referred to.

[1] These groups are indicated in the following pages by the initials L. C., M. C., U. C.

I have included in the list such plants from New Brunswick as are known to me. Those from Grand Lake in that Province are I believe on the horizon of the Middle coal formation, though tending to the Upper. A collection formed by Sir W. E. Logan at Baie de Chaleur, in beds of the Lower and probably Middle coal formation, includes also some species which in Nova Scotia are more characteristic of the Upper coal formation. This apparent mixture of plants of different horizons, may be a consequence of the comparatively small thickness of the New Brunswick coal formation.

In the present unsettled state of the species of coal plants, it is with much diffidence that I venture to publish this list, which will without doubt admit of many corrections and improvements, even in the memoir on the formation of the Nova Scotia coals, with which I propose to follow it. I have, however, endeavored to avoid adding to the load of synonyms, and have in all doubtful cases leaned to the side of identity with known species rather than to that of giving new names. I may add, that the increase of my collection has enabled me to reunite many specimens which I had regarded as representatives of distinct species. But for the large number of specimens which I have been enabled to examine, I should certainly in the case of several variable species, as for example *Alethopteris lonchitica* and *Lepidodendron corrugatum*, have erred in this way. I am constantly more and more convinced that no satisfactory progress can be made in fossil botany without studying the plants as they occur in the beds in which they are found, or in large numbers of specimens collected from those beds, so as to ascertain the relation of their parts to each other.

Dadoxylon, Unger.—Large quantities of drifted coniferous trunks are found in the sandstones of the coal formation in Nova Scotia; but, after slicing more than one hundred specimens, the following are the only species I can distinguish. It is to be observed, however, that the different states of preservation of these trunks render their study and comparison very difficult.

Species.—Dadoxylon Acadianum, *s. n.*, M. C.; D. materiarium, *s. n.*, M. and U. C.; D. antiquus, *s. n.*, L. C.; D. annulatum, *s. n.*, M. C.

Araucarites, Unger.—*Species.*—Araucarites gracilis, *s. n.*, U. C.

Sigillaria, Brongt.—Under this name I include four subgenera, viz., (1.) *Favularia* of Sternberg, of which *S. elegans* is the type; (2.) *Rhytidolepis* of Sternberg, of which *S. scutellata* is the type; (3.) *Sigillaria* proper, of which *S. reniformis* is the type; (4.) *Clathraria* Brongt., of which *S. Menardi* is the type.

To these may perhaps be added *Asolanus* of Wood (*Proc. Philad. Ac. Sci.*), though most of the specimens of *Sigillaria* destitute of ribs are only portions of old trunks of the ribbed species. With these sub-genera I would place *Syringodendron* and *Calamodendron* as members of the gymnospermous family *Sigillariaceæ*. *Stigmaria* may be retained as a provisional genus, to include roots not connected with the trunks.

Species.—Sigillaria (Favularia) elegans *Brongt.*, M. C.; S. (Fav.) tessellata *Brongt.*, M. C.; S. (Rhytidolepis) scutellata *Brongt.*, M. and U. C.; S. (Rh.) Schlotheimiana *Brongt.*, M. C.; S. (Rh.) Saullii *Brongt.*, M. C.; S. Brownii *Dawson* (*Jour. Geol. Soc.*, x.), M. C.; S. reniformis *Brongt.*,

M. C.; S. levigata *Brongt.*, M. C.; S. planicosta, *s. n.*, M. C.; S. catenoides, *s. n.*, M. C.; S. striata, *s. n.*, M. C.; S. ———, M. C., a small erect stem, somewhat like *S. flexuosa*; S. (Clathraria) Menardi *Brongt.*, U. C. and M. C.; S. (Asolanus) Sydnensis, *s. n.*, M. C.; S. organum *L. & H.*, M. C.; S. elongata *Brongt.*, M. C.; S. flexuosa *L. & H.*, M. C.; S. pachyderma *L. & H.*, M. C.; S. (Fav.) Bretonensis, *s. n.*, M. C.; S. eminens, *s. n.*, M. C.; S. Dournaisii *Brongt.*, M. C.; S. Knorrii *Brongt.*, M. C.

Syringodendron, Brongt.—Obscure specimens, referable to a narrow-ribbed species of this genus, occur in the Lower Carboniferous beds at Horton and Onslow.

Stigmaria, Brongt.—Under this name I place all the roots of *Sigillariæ* occurring in the Carboniferous rocks of Nova Scotia. They belong, without doubt, to the different species of sigillaroid trees, but it is at present impossible to determine to which; and the specific characters of the Stigmariæ themselves are, as might be anticipated, evanescent and unsatisfactory.

Species.—Stigmaria ficoides *Brongt.*

Calamodendron, Brongt.—This genus is evidently quite distinct from *Calamites* proper. The calamite-like cast is a pith or internal cavity, surrounded by a thick cylinder of woody tissue consisting of scalariform vessels and woody fibres with one row of round pores; external to this is a bark of cellular and bast tissue. The structure appears to be allied to that of *Sigillaria*, and is one of the most common in the beds of bituminous coal.

Species.—Calamodendron approximatum *Brongt.*, M. C.; C. obscurum, *s. n.*, M. C.

Cyperites, L. & H.—These elongate linear leaves have two or three ribs and the central band between the ribs raised above the margin; one species has been seen attached to *Sigillaria Schotheimiana.*

The leaves of *Sigillaria elegans* are different, being as broad as the areoles of the stem and with several parallel veins.

Antholithes, Brongt.—I include under this name spikes of inflorescence, or of fruits, usually showing buds or scaly floral leaves, and sometimes ovate fruits, which may be young *Rhabdocarpi* or *Trigonocarpi.* I have not seen them attached to stems; but their associations would lead me to suppose that they may have belonged to *Sigillaria* or *Calamodendron.* Stems of *Sigillaria* of the groups *Rhytidolepis* and *Favularia* have rings of abnormal scars at intervals, which may have borne such spikes of fruit. No such marks are seen on the stems of other subgenera of *Sigillaria*, which probably bore fruit at their summits.

Species.—Antholithes rhabdocarpi, *s. n.*, M. C.; A. pygmæa, *s. n.*, M. C.; A. squamosa, *s. n.*, U. C.; A. ———, *s. n.*, M. C., indistinct, but apparently different from those above described.

Trigonocarpum, Brongt.—*Species.*—Trigonocarpum Hookeri *Dawson* (*Jour. Geol. Soc.*, vol. xvii), M. C.; T. Sigillariæ, *s. n.*, M. C.; T. intermedium, *s. n.*, M. C.; T. avellanum, *s. n.*, M. C.; T. minus, *s. n.*, M. C.; T. rotundum, *s. n.*, M. C.; T. Nœggerathi *Brongt.*, U. C.

The *Trigonocarpa* are very abundant in some beds of the Middle coal formation. Most of them are fruits of *Sigillariæ*, some of them perhaps of Coniferæ.

RHABDOCARPUS, Göp. & Berg.—*Species.*—Rhabdocarpus ———, *s. n.*, M. C.; R. insignis, *s. n.*, U. C.

CALAMITES, Suckow.—*Species.*—Calamites Suckowii *Brongt.*, M. C. and U. C. This species is one of the most common in an erect position. It has verticillate branchlets with pinnate linear leaflets. C. Cistii *Brongt.*, M. C. Often found erect. Its leaves are verticillate, simple, linear, striate, apparently one-nerved and 3 inches long. C. cannæformis *Brongt.*, M. C.; C. ramosus *Artis*, M. C.; C. Voltzii *Brongt.*,—(irregularis *L. & H.*), M. C. Often erect. Has large adventitious roots. C. dubius *Artis*, U. C. and M. C.; C. Nova Scotica, *s. n.*, M. C.; C. nodosus *Schlot.*, M. C.; C. arenaceus? *Jæger*, M. C.

EQUISETITES, Sternberg.—*Species.*—Equisetites curta, *s. n.*, M. C. Short thick stems, enlarging upward and truncate above, joints numerous, sheaths as long as the joints, with unequal acuminate keeled points. Lateral branches or fruit with longer leaf-like points. Has the characters of *Equisetites*, but its affinities are quite uncertain.

ASTEROPHYLLITES, Brongt.—*Species.*—Asterophyllites foliosa *L. & H.*, M. C.; A. equisetiformis, *L. & H.*, M. C.; A. grandis *Sternberg*, M. C.; A. tuberculata? *Sternberg*, M. C.; A. trinervis, *s. n.*, M. C.

ANNULARIA, Sternberg.—*Species.*—Annularia galioides *Zenker*, U. C. and M. C.

SPHENOPHYLLUM, Brongt.—*Species.*—Sphenophyllum emarginatum *Brongt.*, M. C.; S. longifolium *Germar.*, M. C. and U. C.; S. saxifragifolium *Sternberg*, M. C.; S. Schlotheimii *Brongt.*, M. C.; S. erosum *L. & H.*, M. C.

The last two species are regarded by Geinitz as varieties of *S. emarginatum*. A specimen of the last named species in Sir William Logan's collection shows a woody jointed stem like that of *Asterophyllites*, giving off branches at the joints. These again branch and bear whorls of leaves. The stem shows under the microscope a single bundle of reticulated or scalariform vessels like those of some ferns, and also like those of *Tmesipteris* as figured by Brongniart. This settles the affinities of these plants, as being with ferns or with *Lycopodiaceæ.*

PINNULARIA, L. & H.—*Species.*—Pinnularia capillacea, *L. & H.*, M. C.; P. ramosissima, *s. n.*, M. C.; P. crassa, *s. n.*, L. C.

All these are apparently branching fibrous stems or roots, of soft cellular tissue with a thin outer bark. Perhaps they are roots of *Asterophyllites*, or perhaps branchlets of an aquatic plant.

NOEGGERATHIA, Sternberg.—*Species.*—Noeggerathia ——— ? *s. n.* Bay de Chaleur, Sir W. E. Logan. A remarkable fragment of a leaf, with a petiole nearly three inches long, and a fourth of an inch wide, spreading abruptly into a lamina, one side of which is much broader than the other, and with parallel veins running up directly from the margin as from a marginal rib. It appears to be doubled in at both edges, and is abruptly broken off. It seems to be a new species, but of what affinities it is impossible to decide. N. flabellata *L. & H.*, M. C.

CYCLOPTERIS, Brongt.—Including *Cyclopteris* proper and sub-genera *Aneimites*, Dn. and *Nephropteris*, Brongt.

Species.—Cyclopteris heterophylla *Göppert*, M. C. and U. C.; C. (Aneimites) Acadica *Dawson* (*Jour. Geol. Soc.*, vol. xvii,), L. C.; C. oblongifola *Göppert*, U. C.; C. (Nephropteris) obliqua *Brongt.*, M. C.; C. (? Neu-

ropteris) ingens *L. & H.*, M. C.; C. oblata *L. & H.*, M. C.; C. fimbriata *Lsqx.*, M. C.; C. hispida, *s. n.*, M. C.

NEUROPTERIS, Brongt.—*Species.*—Neuropteris rarinervis *Bunbury*, M. C.; N. perelegans, *s. n.*, M. C.; N. cordata *Brongt.* (and var. *angustifolia*), M. C. and U. C.; N. Voltzii *Brongt.*, U. C.; N. gigantea *Sternb.*, M. C. and U. C.; N. flexuosa *Sternb.*, M. C.; N. heterophylla *Brongt.*, M. C. and U. C.; N. Loshii *Brongt.*, M. C.; N. acutifolia *Brongt.*, M. C.; N. conjugata *Göpt.*, M. C.; N. attenuata *L. & H.*, M. C.; N. dentata *Lsqx.*, M. C.; N. Soretii *Brongt.*, M. C.; N. auriculata *Brongt.*, M. C.; N. cyclopteroides, *s. n.*, M. C.

ODONTOPTERIS, Brongt.—*Species.*—Odontopteris Schlotheimii *Brongt.*, M. C. and U. C.; O. antiqua, *s. n.*, L. C.?, O. subcuneata *Bunbury*, M. C.

DICTYOPTERIS, Gutb.—*Species.*—Dictyopteris obliqua *Bunbury*, M. C.

LONCHOPTERIS, Brongt.—*Species.*—Lonchopteris tenuis, *s. n.*, M. C.

SPHENOPTERIS, Brongt.—*Species.*—Sphenopteris munda, *s. n.*, M. C.; S. hymenophylloides *Brongt.*, M. C. and U. C.; S. latior, *s. n.*, M. C. and U. C.; S. decipiens *Lsqx.*, M. C.; S. gracilis *Brongt.*, M. C.; S. artemisifolia *Brongt.*, M. C.; S. Canadensis, *s. n.*, M. C.; S. Lesquereuxii *Newberry*, M. C.; S. microloba *Guttbier*, M. C.; S. obtusiloba? *Brongt.*, M. C.

PHYLLOPTERIS, Brongt.—*Species.*—Phyllopteris antiqua, *s. n.*, M. C.

ALETHOPTERIS, Sternberg.—*Species.*—Alethopteris lonchitica *Sternb.*, M. C. and U. C.; A. heterophylla *L. & H.*, L. C.; A. grandini *Brongt.*, M. C.; A. nervosa *Brongt.*, M. C. and U. C.; A. muricata *Brongt.*, M. C. and U. C.; A. pteroides *Brongt.* (Brongnartii *Göppert*), L. C. or M. C.; A. Serlii *Brongt.*, M. C.; A. grandis, *s. n.*, M. C.

PECOPTERIS, Brongt.—*Species.*—Pecopteris arborescens *Schlot.*, M. C. and U. C.; P. abbreviata *Brongt.*, M. C. and U. C.; P. rigida, *s. n.*, U. C.; P. unita *Brongt.*, M. C. and U. C.; P. plumosa *Brongt.*, M. C.; P. polymorpha *Brongt.*, M. C.; P. acuta *Brongt.*, M. C.; P. longifolia *Brongt.*, M. C.; P. tœniopteroides *Bunbury*, M. C.; P. Cyathea *Brongt.*, M. C.; P. æqualis *Brongt.*, M. C.; P. Sillimani? *Brongt.*, M. C.; P. villosa *Brongt.*, M. C.; P. Bucklandii *Brongt.*, M. C.; P. oreopteroides *Brongt.*, M. C.; P. decurrens *Lsqx.*, M. C.; P. Plunckenetii *Sternb.*, M. C.

BEINERTIA, Göppert.—*Species.*—Beinertia Göpperti, *s. n.*, M. C. and U. C.

HYMENOPHYLLITES, Göppert.—*Species.*—Hymenophyllites pentadactyla, *s. n.*, M. C.

PALÆOPTERIS, Geinitz.—*Species.*—Palæopteris Hartii, *s. n.*, M. C.; P. Acadica, *s. n.*, U. C.

CAULOPTERIS, L. & H.—Several small erect stems at the Joggins seem to be trunks of ferns, but are too obscure for description.

PSARONIUS, Cotta.—Trunks of this kind must be rare in the Nova Scotia coal fields. A few obscure stems surrounded by cord-like aerial roots have been found, and probably are remains of plants of this genus.

MEGAPHYTON, Artis.—*Species.*—Megaphyton magnificum, *s. n.*, M. C.; M. humile, *s. n.*, M. C.

LEPIDODENDRON, Sternberg. — *Species.* — Lepidodendron corrugatum *Dawson* (*Jour. Geol. Soc.*, vol. xv), L. C.; L. Pictoense, *s. n.*, M. C.; L. rimosum *Sternberg*, M. C.; L. dichotomum *Sternberg* (L. Sternbergii *L. & H.*), M. C. and L. C.; L. decurtatum, *s. n.*, M. C.; L. undulatum *Stern-*

berg, M. C. and U. C.; L. dilatatum *L. & H.*, M. C.; L. ——, like tetragonum *Göpt.*, L. C.; L. binerve *Bunbury*, M. C.; L. tumidum *Bunbury*, M. C.; L. gracile *Brongt.*, M. C.; L. elegans *Brongt.*, M. C.; L. plumarium *L. & H.*, M. C.; L. selaginoides *Sternb.*, M. C.; L. Harcourtii (*Witham*), M. C.; L. clypeatum? *Lsqx.*, M. C. and U. C.; L. aculeatum *Sternberg*, M. C.

Halonia, L. & H.—A specimen probably referable to this genus from Grand Lake, in the collection of C. F. Hartt.

Lepidostrobus, Brongt.—*Species.*—Lepidostrobus variabilis *L. & H.*, M. C.; L. squamosus, *s. n.*, M. C.; L. longifolius, *s. n.*, M. C.; L. ——, M. C. Acute trigonal leaves, small. L. ——, L. C. Round, with obscure scales and remains of long leaves. L. trigonolepis *Bunbury*, M. C.

Lepidophyllum, Brongt.—*Species.*—Lepidophyllum lanceolatum *L. & H.*, M. C. and U. C.; L. trinerve? *L. & H.*, U. C.; L. majus? *Brongt.*, M. C.; L. ——, U. C. Broad ovate, short, pointed, one nerved, half an inch long. L. intermedium *L. & H.*, M. C.

Halonia, *Lepidostrobus* and *Lepidophyllum*, including only parts of *Lepidodendron* and *Lepidophloios*, are to be regarded as merely provisional genera.

Lepidophloios, Sternberg.—Under this genus I include, on the evidence of numerous specimens, those plants known under the names *Ulodendron* L. & H., *Bothrodendron* L. & H., and *Lomatophloios* Corda, and in part *Halonia*, *Lepidostrobus*, and *Lepidophyllum*. These trees have more or less elevated areoles or leaf bases, rhombic in outline, and terminated by rhombic scars, bearing long, narrow, one-nerved leaves. The fruit consists of large strobiles borne on the sides of the stem and branches. The internal structure presents a large cellular pith, a slender cylinder of scalariform vessels, a very thick cellular and corky bark, and a dense rind or epidermis. They appear to have branched seldom and dichotomously, and are nearly related to *Lepidodendron*. They are abundant in the Middle coal formation.

Species.—Lepidophloios Acadianus, *s. n.*, M. C.; L. prominulus, *s. n.*, M. C.; L. parvus, *s. n.*, U. C. and M. C.; L. platystigma, *s. n.*, M. C.; L. tetragonus, *s. n.*, M. C.

Diplotegium, Corda.—*Species.*—Diplotegium retusum, *s. n.*, M. C.

Knorria.—Nearly all the plants referred to this genus, in the Carboniferous rocks, are, as Göppert has shown, imperfectly preserved stems of *Lepidodendron*. In the Lower coal formation many such Knorria forms are afforded by *L. corrugatum*.

Species.—Knorria Sellonii *Sternberg*, M. C.

This appears different from the ordinary *Knorriæ*. Its supposed leaves may be aerial roots. It has a large pith cylinder with very distant tabular floors, like Sternbergia.

Cordaites, Unger, (*Pycnophyllum*, Brongt.)—*Species.*—Cordaites borassifolia *Corda*, M. C.; C. simplex, *s. n.*, M. C. and U. C.

Cardiocarpum, Brongt.—*Species.*—Cardiocarpum fluitans, *s. n.*, M. C.; C. bisectatum, *s. n.*, M. C.; C. *like* marginatum, M. C.; C. *allied to* C. latum *Newberry*, M. C.

These Cardiocarpa are excessively abundant in the roofs of some coal

seams; and the typical ones must have been samaras or winged nutlets. They must have belonged to phænogamous plants, and certainly are not the fruits of *Lepidodendron*, though some of the spore-cases of this genus have been described as *Cardiocarpa*. These I propose to place under the provisional genus *Sporangites*.

SPORANGITES, Dawson.—*Species*.—Sporangites papillata, *s. n.*, M. C.

I propose the provisional generic name of *Sporangites* for spores or spore cases of *Lepidodendron*, *Calamites* and similar plants, not referred to the species to which they belong. The present species is round, about one inch in diameter, and covered with minute raised papillæ or spines. It abounds in the roof of several of the shaly coals in the Joggins section, and especially in one in group XIX of that section.

S. glabra, *s. n.* About the size of a mustard seed, round and smooth. Exceedingly abundant in the Lower Carboniferous coal measures of Horton Bluff, with *Lepidodendron corrugatum*, to which it possibly belongs. A similar spore-case, possibly of another species of *Lepidodendron*, occurs rarely in the Middle coal formation at the Joggins.

STERNBERGIA, Artis.—This provisional genus includes the piths of *Dadoxylon*, *Sigillaria*, and other plants, usually preserved as casts in sandstone, retaining more or less perfectly the transverse partitions into which the pith-cylinders of many coal-formation trees became divided in the process of growth. These fossils are most abundant in the Upper coal formation, but occur also in the Middle coal formation. The following varieties may be distinguished:

(*a*) Var. *approximata*, with fine uniform transverse wrinkles. This is usually invested with a thin coating of structureless coal.

(*b*) Var. *angularis*, with coarser and more angular transverse wrinkles. This is the character of the pith of *Dadoxylon*.

(*c*) Var. *distans*, usually of small size, and with distant and irregular wrinkles. This is sometimes invested with wood having the structure of *Calamodendron*, and perhaps is not generically distinct from *C. approximatum*.

(*d*) Var. *obscura*, with distinct and distant transverse wrinkles, but not strongly marked on the surface. This is the character of the pith cylinders of *Sigillaria* and *Lepidophloios*.

ENDOGENITES, L. & H.—Many sandstone casts, answering to the character of the plants described under this name by Lindley, occur in the Upper coal formation. They are sometimes three inches in diameter and several feet in length, irregularly striate longitudinally, and invested with coaly matter. Sometimes they show transverse striation in parts of their length. I believe they are casts of pith cylinders of the nature of *Sternbergia*, and probably of sigillaroid trees.

SOLENITES, L. & H.—Plants of this kind are found in the sandstones of the Upper coal formation of the Joggins.

For all the specimens noted in the above list, as collected by Sir W. E. Logan, Richard Brown, Esq., of Sydney, Cape Breton, Henry Poole, Esq., of Glace Bay, C. B., and G. F. and C. B. Matthew and C. F. Hartt, Esqs., St. John, New Brunswick, I am indebted to the kindness of those gentlemen. To Mr. Brown, especially, I am under great obligations for his

liberality in placing at my disposal his large and valuable collection of the plants of the Cape Breton coal field.

The general conclusions deducible from the above catalogue, as well as detailed descriptions of the new species, I hope to give more fully hereafter, when I shall have completed my examination of the microscopic structure of the several coal seams. In the mean time the following summary may be useful:

1. Of 192 nominal species in the list, probably 44 may be rejected as founded merely on parts of plants, leaving about 148 true species.

2. Of these, on comparison with the lists of Unger, Morris, and Lesquereux, 92 seem to be common to Nova Scotia and Europe, and 59 to Nova Scotia and the United States. Most of these last are common to Europe and the United States. There are 50 species peculiar, in so far as known, to Nova Scotia, though there can be little doubt that several of these will be found elsewhere. It would thus appear that the coal flora of Nova Scotia is more closely related to that of Europe than to that of the United States, a curious circumstance in connection with the similar relationship of the marine fauna of the period; but additional information may modify this view.

3. The greater part of the species have their headquarters in the Middle coal formation, and scarcely any species appear in the Upper coal formation that are not also found in the former. The Lower coal formation, on the other hand, seems to have a few peculiar species not found at higher levels.

4. The characteristic species of the Lower coal formation are *Lepidodendron corrugatum*, and *Cyclopteris Acadica*, both of which seem to be widely distributed at or near this horizon in Eastern America, while neither has yet been recognized in the true or Middle coal measures. In the Upper coal formation *Calamites Suckowii*, *Annularia galioides*, *Sphenophyllum emarginatum*, *Cordaites simplex*, *Alethopteris nervosa*, *muricata*, etc., *Pecopteris arborescens*, *P. abbreviata*, *P. rigida*, *Neuroptis cordata*, *Dadoxylon materiarium*, *Lepidophloios parvus*, *Sigillaria scutellata*, are characteristic plants, though not confined to this group.

5. In the Middle coal formation, and in the central part of it, near the greater coal seams, occur the large majority of the species of *Sigillaria*, *Calamites*, *Lepidodendron* and *Ferns*; some of the species ranging from the Millstone grit into the Upper coal formation, while others seem to be more narrowly limited. It is to be observed, however, that as we leave the central part of the system, the total number of species diminishes both above and below, and that it is only in those beds which hold large numbers of plants *in situ*, or nearly so, that we can expect to find a great variety of species, and especially the more delicate and perishable organisms.

It is also quite observable in the Joggins section that while some beds supported *Sigillaria*, others, in the same part of the system, carried *Calamites*, others, mixtures of these with other plants; so that differences of soil, moisture, etc., frequently cause neighboring beds to be more dissimilar in their fossil contents than others much more widely separated. These local and temporary differences must always have occurred in the deposition of the coal measures, and should not be confounded with those general changes which are connected with lapse of time.

4. *Brief Report of J. D. Whitney, State Geologist of California, on the progress of the Geological Survey*, to his Excellency Leland Stanford, Governor of the State, dated, *Office of the Geological Survey, San Francisco*, Nov. 26, 1863.—"The earlier meeting of the Legislature, under the new constitution, makes it necessary that the annual synopsis of the operations of the Geological Survey should be transmitted to you just as the field operations for the season are about closing. I will, therefore, only attempt to set forth, as briefly as possible, the plan which we have followed during the past summer, adding a statement of our financial position and of what we propose to do in the way of publishing, in order that the Legislature may take early action on the same—as will be necessary to be done, if the work is to go on without interruption.

As stated by me, in my address before the Legislature in March last on the relations of the Geological Survey to the interests of the State, our labors during the season which is now closing have been directed to extending our reconnoissance over as large a portion of the previously unexplored and geologically unknown region of the State as was possible; in order that, if the survey were discontinued this winter, we might be able to present some sort of a connected view of the geology of California. With this aim, we have devoted our attention chiefly to the Sierra Nevada, from Fort Tejon to the northern line of the State, and have added much to our knowledge of the geography and geology of that great chain of mountains, especially of that portion which lies between the parallels of 37° and 40°. There are only three counties in the State in which some work has not been done by the Survey, and these are Klamath, Humboldt and Mendocino counties, in which Indian difficulties have hitherto rendered it almost impossible for our small party to operate to any advantage, or without considerable risk.

The organization of the corps has remained nearly the same as last year; but the smallness of the appropriation made by the last Legislature has had its effect in cutting down the survey to some extent. Prof. Brewer has been employed as Assistant Geologist and Botanist, and has been constantly in the field from April 1st up to the present time. During a portion of this time he was accompanied by Clarence R. King, as a volunteer assistant. Hoffman has also been uninterruptedly engaged in the topographical work. During the early part of the season he was with Prof. Brewer and myself in the high Sierra, but he was afterward employed in completing the map of the vicinity of the Bay of San Francisco, both in the field and office. The field work is now complete, and the map will be ready for the engraver before the commencement of the session of the Legislature, and can be examined by those of the members who may be interested in the progress of the work. The map of the vicinity of Monte Diablo, on a scale of two inches to the mile, is also ready for the engraver.

A large amount of material has been collected during the past season toward a map of the central portion of the Sierra Nevada. From Wackenreuder, however, we have had no assistance, as he has been engaged in the service of the United States. The maps commenced by him last year remain in the same condition which they were in at the date of my last year's synopsis.

Mr. Gabb has continued the work of figuring and describing the fossils collected by the survey; he has also been employed during a part of the time in the field.

In the zoological department, Dr. Cooper has been engaged from April 1st, a part of the time at Santa Barbara and on the adjacent islands, collecting marine and land animals, and afterward in the Sierra Nevada. He is now employed in preparing a catalogue of the animals of the State.

Professor Brewer has continued the collection of botanical specimens, and chiefly in the high Sierra, where much that is new and interesting has been discovered, no collectors in this department having ever before visited our highest mountain regions. The task of working out the botanical and zoological collection has been proceeded with, and portions of reports received from some of the eminent authorities to whom various subdivisions of the collections had been referred.

It seems proper, at the present stage of the survey, to make some statement in regard to the probable amount of time and money required to complete the work. Indeed, in my address before the last Legislature, I promised to do so during the coming winter. It is especially necessary that some action should be taken soon in reference to this matter, as the amount and character of the printing to be done this winter will depend on the settlement of the question whether the survey is to be continued; and if so, for what probable length of time.

Undoubtedly, were the State in a position in which economy in the public expenditures was not of the highest importance, there would be no question that the survey might be continued to an indefinite period with advantage, since all will admit that the results proposed to be gained by a work of this kind, if it be properly conducted, could not fail to be beneficial to the community. Thus, no one in California objects to the minute accuracy and consequent expense of the Coast Survey work upon our shores, since the burden of payment does not fall directly on our shoulders.

The amount of time required for our work, combining, as it necessarily does, a topographical with a geological survey, and adding thereto a natural history survey, depends entirely on the degree of accuracy with which it is carried on. I have already stated, in previous communications to the Executive and Legislature, how much time and money have been and are still being expended in other countries in works of this kind, as for instance in Great Britain and France. But the degree of perfection to be aspired to in such an undertaking must be governed by circumstances; and if we consider that it would require a population of 71,000,000 within the borders of our State in order that our population should equal that of England in density, it will be readily seen that what would be feasible in that country might be an impossibility here.

The farthest limit of completeness to which I ever aspired to carry this survey was the completion of a map of the whole State on a scale of six miles to the inch, making nine sheets, each about nine feet square, with the geology worked out on a corresponding scale of accuracy. Further experience in the State, and more knowledge of what the people expect, and a personal experience of the condition of the treasury, have convinced me of the impossibility of carrying out this undertaking,

for which certainly not less than fifteen years would be required. I am fully convinced that the work, carried to this extent of completeness, would be of sufficient benefit to the State to justify its being done; but I am also equally well assured in my own mind that the people would not recognize the value of the survey until after it was completed, and that consequently it would be impossible to carry it forward on a matured plan without danger, and almost certainty, of its being interrupted.

In weighing the matter carefully, I have concluded that four years longer is the extent of time to which the survey should be protracted, with a liberal appropriation—of not less than $40,000 per year. But I am, furthermore, of opinion that the survey should be suspended altogether, until such time as the finances of the State are placed on a cash basis, as I find that the delay and anxiety caused by the necessity of borrowing to meet the advances required by the treasury's being from one to two years behindhand in the payment of the appropriations, is too disagreeable and prejudicial to the interests of the State and the progress of the work to allow me to be willing to continue on the system any longer.

Should the financial condition of the State be improved, and the necessary appropriations made, we might in four years accomplish the following amount of work:

We should prepare a map of Central California, extending from the parallel of 37° to that of 40° 20′—probably on a scale of three miles to the inch. This map would embrace the area occupied by about nine-tenths of the population of the State. It is possible that we might be able to complete the map of the Coast Ranges, from Santa Barbara to Monterey, which was commenced two years ago. Detailed maps of various important mining regions, including that of Washoe, would also be given. The main object of the survey, however, would be the elucidation of the mineral resources of the State, including everything which bears on the working of the mines, and reducing their products to a marketable condition. We should require a commodious and well arranged laboratory, where, with the necessary assistance in that department, all questions touching the metallurgic treatment of our ores and minerals might be investigated, and analyses made of our mineral waters and substances of economical value. The zoological and botanical departments of the survey would also receive a share of attention.

The result of the survey, in case it should be actively continued for four years longer, would probably be comprised in about five large volumes, of which the first would embrace the physical geography and general geology of the State; the second, the description of the fossils found in our rocks, both those of animal and vegetable origin; the third the economical geology, including all that relates to mines and mineral products of economical value; the fourth, the botany and zoology; and the fifth would contain such maps, sections and other illustrations as were not introduced into the other volumes, or printed with the text. It is possible, however, that some of these volumes might have to be divided into two parts, owing to the large quantity of matter it might be desirable to publish.

If it be deemed necessary to close the survey at once and permanently, no further appropriation being made except for the purpose of preparing for publication such of the matter as is already collected, so far as the same can be made available without any additional field-work, we shall be able to furnish two volumes, and perhaps three, according to the amount which may be appropriated for preparing the materials in hand for the press, and for finishing up such work as is already near completion.

The appropriation for the survey, made for the second year of its continuance, by the Legislature of 1862, having just been paid, a volume is now due the State, in accordance with the Act passed at that session, authorizing the printing of one volume and appropriating $3,000 therefor. In accordance with that Act and with your Excellency's approbation, the work has already been begun and will be carried on as rapidly as possible, provided the Board of Examiners will audit my estimate for the printing, to the extent authorized by the law, so that I can make the necessary financial arrangements and be enabled to pay for the work as it progresses, by borrowing on the security of the State warrant.

By constitutional limitation, the office of State Geologist will expire in the course of the year 1864, and, as I suppose, on the 21st of April,—the date of the approval of the Act authorizing the survey and creating the office, although I did not enter upon the duties of State Geologist until November 14, 1860. Of course, unless reappointed by the present Legislature, my duties will cease at the time above mentioned.

The printing of another volume of the report can be commenced whenever an appropriation is made for the same by the Legislature, and the money provided for the purpose. One of the two volumes due the State whenever the appropriation of 1863 is paid, will constitute a portion of the final report, whether the survey be continued or not. The other volume will not be a portion of a final report, unless the survey should be stopped by the Legislature this winter. It is impossible to specify the sum required for the printing until it has been decided whether the report will be a final one—that is to say, whether the survey is to go on.

The total amount appropriated by the Legislature for the suvvey, from the beginning, has been $70,000. Of the $20,000 appropriated by the last Legislature, the sum of $11,487.98 had been expended from April 1st to September 30, 1863. Our expenses from October 1st to December 31st of this year may be estimated at $4,750; leaving only about $3,750 to go on with after the new year. It may be added, that no part of the last appropriation has been received, and that no iuformation can be procured at the State Treasurer's office as to when it is likely to be.

The question of providing a fire-proof building for the State geological collections, and of the proper use and disposition to be made of the same, is one which should engage the attention of the Legislature during the coming session. For my views on this subject, I would refer to the report to be presented to this Legislature early in the session by the Board of Commissioners appointed last year to take this matter into consideration. This Board, consisting of the State Geologist, the Surveyor General and the Superintendent of Public Instruction, is required to report to the Legislature, on or before the second Monday of December, on the possibility of establishing a State University, embracing an Agricultural Col-

lege, a School of Mines, and a Museum including the geological collections of this State."

[The telegraph, on the 12th of April, brought information that the Legislature of California had decided on the continuation of the Survey. —EDS.]

5. *Large Mass of Native Copper.*—Mr. J. B. TOWNSEND, agent of the Minnesota Mine, has communicated to one of the Editors the following facts regarding the large mass of copper found in 1857:—"The 'great mass' of the Minnesota Mine was discovered in February, 1857, between the adit and ten fathom level, or about 120 feet below the surface. It was imbedded in the belt of conglomerate which forms the foot-wall of the Minnesota vein. Previous to its discovery, the regular vein, at the junction of the trap and conglomerate, had been removed. The foot-wall of the vein, at the place where the great mass was found, was perfect and regular as in other cases; the lode was also rich in mass copper. The great mass was discovered only by small strings or pieces of copper extending into the conglomerate. The mass itself was 45 feet in length, about 22 feet at the greatest width, and the thickest part was more than 8 feet. It was over 90 per cent copper, and weighed about 420 tons. It required 13 months to complete the cutting up and sending it to the surface. Some 30 men were employed in cutting at first, but as the piece became smaller, only a few could work at the cutting at a time. Several heavy blasts were necessary to loosen the mass from its bed. At the last blast, or charge, 30 kegs of powder (750 lbs.) were used. The whole amount of powder consumed in the various trials was 95 kegs, (2375 lbs.). The principal features of this mass of more than ordinary interest were its great weight in one solid body, its remarkable purity, and its occurring outside of the regular vein in the conglomerate rock."

6. *Laurentian Rhizopods of Canada.* (Extract of a letter from T. STERRY HUNT, F.R.S., to J. D. DANA, April 2, 1864.)—The mineralogical relations of the fossil Rhizopod from the Laurentian limestones of Canada, mentioned in Sir W. E. Logan's note in the last number of the *Journal*,[1] are full of interest. The calcareous septa which form the skeleton of this Foraminifer are unchanged, while the sarcode has been replaced by certain silicates, which have not only filled up the chambers, cells, and septal orifices, but have been injected into the minute tubuli, which are thus perfectly preserved, as may be seen on removing the calcareous matter by an acid. The replacing silicates are a white pyroxene, serpentine, and a dark green alumino-magnesian silicate near chlorite and loganite. The pyroxene and serpentine are often found in contact, filling contiguous chambers in the fossil, and were evidently formed in consecutive stages of a continuous process.

These observations confirm the views which I have already expressed in the pages of the *American Journal of Science*, as to the aqueous origin of silicated minerals like those above named, which as I have asserted must have been deposited as the result of chemical processes from waters at the earth's surface. The resemblance between the mode of preservation of the ancient Laurentian Foraminifera, and that of the allied forms in Tertiary and recent deposits, which as Ehrenberg, Bailey and Pourtales have shown, are injected with glauconite, is obvious.

[1] On organic remains in the Laurentian rocks of Canada, page 272.

7. *Ueber zwei neue dyadische Pflanzen;* by Dr. H. B. GEINITZ (*Jahrb. für Min.*, etc., 1863, pp. 525–530).—Of the two new plants of the Permian here described by Dr. Geinitz, one is from the *Rothliegende* of Ottendorf near Braunau in Bohemia; it is named *Schützia anomala*, and is a stem in fruit; it is regarded by the author as probably Coniferous, and near the living *Cryptomeria.* The other is from the lower Permian of Hohenelbe, and is apparently a root, as the name given it, *Rhizolithes Kablikæ*, implies. The paper is illustrated by two plates.

8. *Beiträge zur Kenntniss der organischen Ueberreste in der Dyas (order permischen Formation zum Theil) und über den Namen Dyas;* by Dr. H. B. GEINITZ. With two plates. (*Jahrb. f. Min.*, 1863, pp. 365–398.)—Dr. Geinitz here describes and figures the *Prosoponiscus problematicus* (which he refers to the Isopod Crustaceans), *Syringopora Fischeri* Gein., *Saurichnites Leisnena* Gein., *Saurian skin* from the lower Permian of Huttendorf near Hohenelbe, and remarks upon the pretended identity of fossils of certain British Carboniferous and Permian schists, and also upon the name *Dyas*, of Marcou, used by him for the Permian.

Under this last head, Dr. Geinitz shows that the Dyas has different limits from those before given to the Permian. Yet we still think, with Murchison, that the accepted name of Permian may without inconvenience and more properly be extended to cover the whole. We see no advantage in a change, and least of all to one based on a mere accident, the number of subdivisions of the formation in a particular region.

9. *Appendix to the Third edition of the Antiquity of Man;* by Sir CHARLES LYELL. Dec., 1863.—This appendix consists of abstracts of recent papers touching on the antiquity of Man and his relations to other animals, along with just and discriminating remarks on the same. Besides papers bearing directly on these topics, there are others on the Continental ice of Greenland, on phenomena of the glacial drift of Scotland and Wales, on the existence of marine animals at various depths in seas abounding in floating ice in Arctic and Antarctic regions, and on the submergence of the Sahara in the Post-pliocene period.

10. *A popular and practical exposition of the Minerals and Geology of Canada;* by E. J. CHAPMAN, Ph.D., Prof. in University College, Toronto. 236 pp., 8vo, with over 200 wood-cuts. Toronto, 1864. W. C. Chewett & Co.—This work, which, in the main, has appeared in a series of articles in the *Canadian Journal of Science and Art*, presents a popular and yet full sketch of the mineralogy and geology of Canada, together with such introductory matter pertaining to both these sciences as would serve to render it a handbook in mineralogy and geology for the Canadian student. It gives, with much detail, the general results of the Geological Survey of Canada, as gathered from the published Reports, and additional information from the results of Prof. Chapman's own observations and the memoirs of other investigators. It is illustrated by numerous wood-cuts, representing, among them—although somewhat coarsely, as the author remarks in his preface—a large number of the fossils characteristic of the several formations; and the most of them are original. While the volume has a special interest in Canada, it has hardly less out of it, with all who would become acquainted with the geology of North America.

III. BOTANY AND ZOOLOGY.

1. *On the Popular Names of British Plants, being an explanation of the Origin and Meaning of the names of our indigenous and most commonly cultivated Species;* by R. C. A. Prior, M.D., etc. London: Williams & Norgate, 1863. pp. 250, 12mo.—A book full of out-of-the-way and interesting lore, such as could be produced only by one who, like Dr. Prior, has much botanical and philological learning, especially of the sources of the English language, and who has patiently studied the old herbals. Apart from the botanical interest, as the author remarks, in tracing back popular names to their remote origin:

"We soon find that we are travelling far away from the humble occupation of the herbalist, and are entering upon a higher region of literature, the history of man's progress, and the gradual development of his civilization. Some of the plants that were familiar to our ancestors in Central Asia bear with us to this day the very names they bore there, and as distinctly intimate by them the uses to which they were applied, and the degree of culture which prevailed where they were given, as do those of the domestic affinities, the various occupations of the primeval family. The names of animals, with which many are compounded, carry us still farther back, or to still more distant regions: for in some cases it is impossible now to deduce any meaning from them at all, and it is probable that the names may have been adopted, with the knowledge of the animal, from an entirely alien nation. In such, for instance, as *hound* and *ox*, we have unquestionable proof that they must have been given to those animals before the existing dialects of our ancient mother tongue had assumed their distinctive form; and this must have been at an immensely remote point of time. For, to educe from the same language others so different from one another, not only in their vocabulary, but in their grammatical constructions and declensions, as were already in their earliest known state the oldest of them with which we are acquainted, the Sanskrit, Latin, Greek, and Gothic, required a period not of centuries merely, but millenia.

"The most interesting, in this respect, of the names that have come down to us, are those which date from a period antecedent to the settlement of the German race in England,—names which are deducible from Anglo-Saxon roots, and are identical, with allowance for dialectic peculiarities, in all the High and Low German and Scandinavian languages, and, what is particularly worthy of our attention, each of them expressive of some distinct meaning. These will prove, what with many readers is a fact ascertained upon other evidence . . . that the tribes which descended upon Britain had entered Europe, not as a set of savages, or wandering pastoral tribes, or mere pirates and warriors, but as colonists, who, rude as they may have been in dress and manners, yet in essential points were already a civilized people. It will be seen at the same time that they must have come from a colder country: for, while the names comprehend the Oak, Beech, Birch, Hawthorn, and Sloe,—trees that extend far into Northern Asia,—they do not comprise the Elm, Chesnut, Maple, Walnut, Sycamore, Holly, or any evergreen, except of the Fir-tribe, or Plum, Pear, Peach, or Cherry, or any other fruit-tree, except the Apple. For

all these latter they adopted Latin names, a proof that at the time when they first came into contact with the Roman provincials on the Lower Rhine, they were not the settled inhabitants of the country they were then occupying, but foreigners, newly arrived there as colonists or conquerors from a country where those trees were unknown."

The transformations and transpositions which many popular names have undergone are curious. The word *Primrose* comes from *Pryme rolles*, the name it bears in the old herbals and manuscripts, written as one word, *Primrole*, by Chaucer. This is an abbreviation of the French *Primeverole*, of the Italian *Primaverola*, a diminutive of the Latin *prima vera*, the *first spring flower*. This in England was familiarized into *prime rolles*, and then into *primrose*, which was at length explained as meaning the first rose of spring, without considering that the flower in question could never have been taken for a rose. *Tube Rose*, from *Tuberose*, i. e., *tuberosa* was an analogous blunder. But, curiously enough, the *Primeverole* of the olden time was not a *Primula* at all, as Dr. Prior shows. The rightful claimant of the name is the Daisy (*Bellis perennis*), a common and conspicuous flower of early spring in the South of Europe, where the *Primula veris* is rare; and it is the Daisy which bears the name in all the old books. Matthioli, in 1586, however, appends the name of *Primula veris*, &c. both to *Bellis* and *Primula*.

"*Primrose peerless*," etymologically traced, turns out to mean *Primula paralyseos*,—a *palsy*, not a *nonpariel* primrose.

Another link of the chain of confusion: our Primrose in the middle ages was called in Latin *Ligustrum;* and the English names *Prim*, *Privet*, (from *Prymet* and *Primprint*, all from the French *prime printemps*, and answering to the modern French *Primevère*,) are standing witnesses of the former state of things. The name of *Ligustrum* having been applied or restored by botanists to the shrub, the English names *Pimprint*, *Prim*, &c., went with it.

Gilliflower (Fr. *Giroflée*, It. *Garofalo*, Lat. *Caryophyllum*) etymologically and historically belongs to the Clove Pink or Carnation, which, indeed, is the Gilliflower of Chaucer and Spenser: but later writers and gardeners have transferred it to the cruciferous plants which now bear the name. The original Gilliflower being a Pink, we may turn to the origin of the latter name. Dr. Prior informs us that it is derived from the low German *pinksten*, Whitsuntide, the Whitsuntide-Gilliflower of old authors, a name shortened from πεντηκοστη, Pentecost, the fiftieth day after Easter.

These specimens may suffice to call attention to a very interesting and useful book. A. G.

2. *Cosson et Germain de Saint-Pierre, Flore des Environs de Paris*, 2ième ed. Paris: Masson et Fils, 1861. pp. 963, 8vo.—*Synopsis Analytique de la Flore des Environs de Paris.* 2ième ed. pp. 581, 24mo.—With these two volumes,—the one in this edition enlarged into a stout octavo, the other a veritable pocket companion for herborizations, comprising the whole botany of the district within the space of 6×4×1 inches,—Parisian botanical students are furnished in an enviable manner. The larger volume is a full and most conscientiously elaborated flora of the region within 24 leagues of Paris, which takes in Fontainebleau, Chartres, Evreux, and Compiegne; and is supplied with a map crowded with de-

tails, synoptical tables, &c. The commonly cultivated plants are included, and the more important ones fully described. Both works are models of their kind. A. G.

3. *Des Fleurs de Pleine Terre, comprenant la Description et la Culture des Fleurs Annuelles, Vivaces, et Bulbeuse de pleine terre, suivies de Classements divers, indiquant l'emploi de ces Plantes et l'époque de leur floraison, de plans de Jardins, avec des examples de leur ornementation en divers genres, etc., etc. Par* VILMORIN–ANDRIEUX, *et cie.* Paris, 1863, pp. 1216, 16mo.—Twenty-eight pages are occupied with succinct prefatory instructions for the raising and propagating of flowering plants. The close of the compact little volume contains lists of choice hardy flower-seeds, of bulbous plants, of the best plants for borders, of the best climbing plants, of desirable sweet-scented flowers, of ornamental fruits, of ornamental grasses, of ferns, of ornamental aquatic plants, of plants for rookeries, of plants for shady places, and of plants picturesque or striking for their foliage, &c. Also, a calendar of the season of flowering of the principal plants described in the body of the work; plans of gardens and examples of different styles of ornamentation; plans for a small country-place and for the grounds of villas; colored plans and detailed illustrations of the flower ornamentation by *plates-bandes* at the *Jardin des Plantes*, the gardens of the *Luxembourg*, *Tuileries*, *Louvre*, &c.; directions for the formation and treatment of lawns; and, finally, a dictionary of the principal botanical and horticultural terms employed in the work, and tables of English, German, Italian, and Spanish names of common flowers, with their French synonyms. Nine hundred and fifty pages of the body of the work are filled with excellent popular descriptions of hardy flowering plants, alphabetically arranged under their French names, followed by their technical names in Latin, with full details as to their garden varieties and their culture. We have no great acquaintance with books of this class, but we know of nothing to compare with this little volume in the English language, nor in the French, except the well-known *Bon Jardinier*, upon the same plan, only extended to general culture. Even for this country it is a treasure, which, if in the English language, would leave little to be desired. As a single volume, it is chubby; but double title-pages are given for the convenience of binding in two volumes, if desired. A. G.

4. *Monographia Generis Lepigonorum. Auctore* N. C. KINDBERG, Upsal, 1863, pp. 48, 4to, tab. 1–3. Separately printed from the *Nova Acta Upsal.*, ser. 3, vol. 4, fasc. 2.—Twenty-five species and a few subspecies are elaborately described, and portions of the plant and magnified seeds are well figured. In adopting, as was to be expected, the excellent name *Lepigonum*, given to this genus by the venerable Fries, in 1817, the author makes out that, in strictness, it antedates *Spergularia*, because Persoon only established a sub-genus, under *Arenaria*, without giving a character or a proper limitation. But it may be insisted that good and sufficient characters are assigned by Persoon; and also that if we neglect this name, we may after all have to take up Haworth's name, *Stipularia*, whenever Palisot's obscure Rubiaceous genus of that name comes to be identified. The seeds are thought to furnish the best specific characters in this genus, although they are admitted to vary considerably and in a part of the species to be either winged or wingless. The primary divi-

sion is into *Leiosperma*, (11 species) and *Trachysperma* (14 species), each sub-divided, from the size of the capsule, into *Macrotheca* and *Microtheca*. One large-fruited species with smooth seeds (*L. macrothecum*) is from California, and two smooth-seeded species with small pods are assigned to our Atlantic coast, as also one rough-seeded, small-fruited one (*L. salinum*), both to our eastern and our western coasts. The group is an interesting one to study, on account of the wide geographical distribution, and the close connexion among the forms, which some would distinguish into numerous species, while others would regard them rather as incompletely segregated derivations of a common stock, or of two or three stocks. A. G.

5. *Kongliga Svenska Fregatten Eugenies Resa*, etc. *Botanik*, 1, 2. (Published by the Royal Society of Sciences of Stockholm.) *Botany of the Galapagos Islands*, by N. J. ANDERSSON.—The first fasciculus of these botanical results of the Voyage of the Swedish Frigate Eugenie, published several years ago, is a general discussion of the vegetation of the Galapagos, in the Swedish language. The second, recently issued, is an *Enumeratio Plantarum in Insulis Galapagensibus hucusque observatarum;* the whole illustrated by 16 plates, 4to. Ever since the publication of Dr. Hooker's elaborate essay on the botany of these islands, they have been regarded with great interest, especially in what relates to the geographical distribution of their vegetable denizens,—an interest which is enhanced by this more recent and complete florula. The number of species is here extended to 392, the *Algæ* omitted; of which one is a *Fungus*, 9 are *Lichenes*, 6 *Hepaticæ*, 4 *Musci*, 31 *Filices*, one *Salviniacea;* the remainder Phænogamous plants. A. G.

6. CAROLI WRIGHT *Lichenes Insulæ Cubæ, curante* EDVARDO TUCKERMAN.—The *Lichenes* of Mr. Wright's collections in Cuba, made during several years past, have been most attentively studied and arranged by Professor Tuckerman. Having completed the work, so far as regards the principal part of the collection, these Lichenes, elaborated with immense labor and care, have been distributed into sets (in all only 20) by Prof. Tuckerman; the species all authoritatively named by him, and furnished to the subscribers to Mr. Wright's collections. With the exception of Lindig's Venezuelan collection, we are assured that no collection of Tropical *Lichenes* has ever been made which would compare with this. Prof. Tuckerman's descriptions and annotations upon the more interesting species are published in the *Proceedings of the American Academy of Arts and Sciences*, and copies of this publication will be furnished to subscribers to the sets. Several sets yet remain for disposal, containing between 144 and 165 species. Those who desire to obtain them may apply to Prof. Gray, Cambridge. The indefatigable collector is still pursuing his botanical investigations in Cuba. A. G.

7. *Observations on the Genus Unio, together with descriptions of new Species, their soft parts, and embryonic forms in the Unionidæ;* by ISAAC LEA, LL.D., Pres. Acad. Nat. Sci. Philad., etc., etc. Vol. X, with 10 plates, 94 pp., 4to. Philadelphia. (Read May 12, 1863, before the Academy of Natural Sciences of Philadelphia, and published in their Journal.)—This tenth volume of Dr. Lea's Memoirs on the Unionidæ is dedicated to Professor Jeffries Wyman. Twenty-five pages are occupied

by the descriptions of new species, and the rest of the volume by observations on the animals and the embryonic forms of 143 species of Unionidæ of the United States. Many of the new species described were collected by Prof. Wyman in South America. Other South American species, with a few from Asia, were contributed by Mr. C. M. Wheatley, and others from Asia by Mr. W. A. Haines.

The number of known species of North American Unionidæ has been increased by the author, since the publication of his ninth volume, by thirty-six, making in all *seven hundred and ten;* and still others, Dr. Lea observes, are in his possession.

Besides descriptions of the shells and animals, Dr. Lea makes some critical remarks on certain subdivisions of the family which have been proposed by Professor Agassiz.

The Introduction announces that the eleventh volume will consist chiefly of indigenous species of Unionidæ and Melanidæ, but with some exotic species of the former, descriptions of which have already appeared at various times in the Proceedings of the Academy.

We may here add, that, in January last, Dr. Lea declined being a candidate for re-election to the office of President of the Academy; whereupon the following resolutions were unanimously adopted:

"That this Academy hereby expresses its most grateful sense of the entire faithfulness, impartiality, and eminent ability with which Dr. Lea has performed the duties of President during the lengthened term of his incumbency.

"That the thanks of this Academy be hereby tendered to Dr. Lea for his most valuable and important services in the capacity of President, and for his many other judicious and liberal favors and continued and successful exertions for the benefit of this Academy, and for the advancement of the interests of science in the United States."

8. *List of the Polyps and Corals sent by the Museum of Comparative Zoology to other Institutes in exchange, with Annotations;* by A. E. Verrill. pp. 29–60 from the *Bulletin of the Museum of Comparative Zoology*, Cambridge, Mass.—This "list" is much more than a list, it containing notes by the author at considerable length on the characters and synonymy of many of the species, and descriptions of a number of new species. The author shows a thorough acquaintance with the department which has been under his charge in the Museum of Comparative Zoology at Cambridge, and contributes much in his paper toward the progress of this department of zoology.

9. *Prospectus of a Monograph of the Tetraoninæ, or Family of the Grouse;* issued by the author, D. G. Elliot.—"It is proposed to commence very shortly the publication of this work, including plates with life-size figures of all the known species.

"Much confusion has always existed regarding the scientific arrangement of this family, especially with that portion of it comprising the Lagopidæ, or Ptarmigan. With a very extensive collection of these, (including the great number received by the Smithsonian Institution, through its various expeditions,) the author trusts that he will be enabled to throw some new light upon these perplexing birds; such as relates to the number of species, geographical distribution, habits, &c.

"Peculiar facilities have been afforded for carrying on an investigation in this family; for not only is the author placed in possession of all the specimens obtainable, but, being in constant correspondence with leading European ornithologists, he is enabled through their kind efforts to be kept thoroughly informed of whatever relates to this work in the museums of the Old World.

"'North America,' says Prince Charles Bonaparte, 'is exceeded by no country in the beauty, number and valuable qualities of her grouse;' and if when that was written, such praise was due, how much more is it now, when numerous additional species have been discovered?

"Of all the members of this family that are now known, two-thirds are natives of the United States. The drawings have been executed with great care from the birds themselves, and each plate is *colored by hand;* and represents the different species in various attitudes, surrounded by the scenery to which they are accustomed. Whenever it is possible, figures of the male, female and young, will be given.

"The same method has been adopted with this work as with the author's former one, entitled a Monograph of the Pittidæ, or Family of Ant Thrushes; and only a limited number of copies have been prepared—in this case, 200—and the drawings are erased from the stones as soon as the requisite number is printed off; thus making it impossible to reproduce the work, unless at the original expense, but causing it to become more valuable to those possessing it.

"The work, imperial folio in size, will be issued in parts—each to contain six plates—to follow each other as rapidly as may be consistent with the proper preparation of such large subjects, and will be furnished to *subscribers only*, at Ten Dollars each, payable on delivery; the number of parts probably not exceeding five. It is intended also to give one or more plates, as may be required, illustrating the *eggs* of the different species.

"The author would beg leave to request those who may desire to subscribe, to sign their names to the accompanying form and enclose it to him, as early as may be convenient, to his residence, No. 21 West 33d street, New York.

"A list of the subscribers will be given with the last number."

New York, Feb. 17th, 1864.

IV. MISCELLANEOUS SCIENTIFIC INTELLIGENCE.

1. *On the Yellow Coloration of faded Photographic Prints;* by M. Carey Lea.[1]—Everything connected with the permanence of photographic products has an interest so vital to photography, that nothing connected with it can be considered as trivial. We are yet groping in the dark as to the causes of failure. "Sulphuration" is a convenient word, but it would be more satisfactory if we had some idea as to the nature of the obnoxious insoluble sulphur compound.

The hypothesis which has for some time past become current is, that the fading depends upon the presence in the print of some sulphur compound, which with time acts upon the silver, converting it, as is said,

[1] Communicated for this Journal by the author, and received too late for insertion in the foregoing portion of the Journal.

into sulphid. Sulphid of silver we know as a jet black substance, and we habitually convert the reduced silver of negatives into sulphid when we wish to intensify them. Why then should the production of sulphid of silver strengthen a negative and destroy a print?

MM. Davanne and Girard answer as follows. Sulphid of silver prepared by itself is, they say, black. But formed in presence of organic matter, the organic matter enters into the composition and the compound is yellow. To prove this, they precipitate a solution of silver with sulphuretted hydrogen, and find it violet black. They again precipitate the same silver solution in presence of starch and obtain a yellow precipitate.

I have paid much attention to the subject of the fading of prints, and had been forcibly struck by the anomaly above referred to. The explanation of the gentlemen just mentioned seemed very satisfactory; but the question appeared to have too much importance to pass it by without verification. The following results were obtained.

In a test tube was placed a little boiled starch; in a second tube, some water. Two or three drops of a five per cent solution of nitrate of silver were added to each and then hydrosulphate of ammonia. *Both* solutions gave a yellowish brown precipitate without the slightest difference in shade or color. The precipitate afforded by hydrosulphate of ammonia could not here differ from that produced by sulphuretted hydrogen, but to remove any doubt on this score, the experiment was carefully repeated with sulphuretted hydrogen. The same result precisely was obtained. As a further confirmation, the experiment was varied by the substitution of another organic substance, viz: collodion, instead of the starch. The result was precisely similar.

The different result obtained by MM. Davanne and Girard can perhaps be explained as follows. The sulphid of silver is a heavy substance, and when thrown down from a simple watery solution it quickly subsides. But solutions thickened with organic matter, such as gum, starch, gelatine, &c., retain a precipitate for a long time in a state of suspension, thus preserving the original yellowish-brown appearance. If, therefore, we prepare solutions as above, and pass HS through them, allowing them to subside, and examine them only after a time, we shall find in the one case a black precipitate below a colorless solution; in the other a brownish viscid liquid. But if we watch the process from the outset, we shall see that the reactions are chemically identical, and differ only in respect to the mechanical suspension which takes place in the one case.

The experiment which I here cite may throw some light on the origin of the yellow color. It appears that when the sulphid of silver is in a state of very fine division, its color is yellowish brown, as may be easily ascertained by treating a very dilute solution (e. g., 1-5000th) of nitrate of silver with hydrosulphate of ammonia. Many substances are only black in consequence of excessive intensity of color. Lampblack, for example, in a state of excessively fine division is yellowish brown. Ink diluted is purple. Claus has shown that the intensely black hydrated sesquioxyd of ruthenium is, when very finely divided, green.

I therefore conclude: 1st. That it is as yet not absolutely demonstrated, (although probable,) that the current opinion, ascribing the fading of pictures to the production of sulphid of silver, is correct.

2d. That if this opinion be correct, there exists no evidence that organic compounds have anything to do with the production of a yellow color, the tint of sulphid of silver found in their presence and in their absence being quite the same shade of yellow-brown.

2. *Magnesium Light for Photography.*—Prof. Roscoe, at a meeting of the Literary and Philosophical Society of Manchester, in January last, stated that the magnesium light, proposed by him and Prof. Bunsen, had been recently tried by Mr. Brothers, and that in 50 seconds a good negative copy of an engraving was obtained in a darkened room; and that this was about equal to another made for comparison in daylight (the sun shining, but with a good deal of fog in the atmosphere) in 50 seconds, in the usual way. Mr. Sonstadt prepares the magnesium wire for this purpose. A burning magnesium wire, 0·297$^{mm.}$ thick, affords the light of 74 stearine candles, of which 5 make a pound; and in 10 hours, 192·2 grms. of such wire would be consumed.—*Reader, March* 5.

3. *Preservation of Animal Substances.*—Pasteur reported to the Academy of Sciences of Paris, in February, a new and simple process for preserving animal substances, the invention of Mr. Pagliari. The liquid is composed of alum, benzoin and water; the surface of the meat is covered with it, as with a varnish, and then it is allowed to dry in contact with the air. Decomposition, he states, is completely prevented for any length of time. The thin film, though invisible to the naked eye, acts as an antiseptic filter, preventing, according to Pasteur's experiments, the entry of fermenting and decomposing matters, whilst permitting evaporation to take place freely.—*Reader, March* 19.

4. *The Difficulties incident to the laying of long Electric Sea Cables.*—Few people can imagine the great mechanical difficulties to be overcome in laying a long cable. Owing to the difficulty of making the joinings properly at sea, the rope cannot be carried out in more than two portions, and there are very few ships capable of conveying the required load in the necessary manner. An electric cable is a difficult thing to coil, indeed no one who inspects it in short lengths would believe it capable of being coiled at all; the cable must, therefore, be laid in the hold, in as large a circle as possible, and the space occupied must be perfectly clear from cross beams, or perpendicular supports for the deck. The cable must be placed so as to load the vessel evenly, and must be so paid out that she shall preserve an even keel, otherwise water ballast must be admitted to keep the vessel in trim. Moreover, with a long cable, the vessel employed should be a steamer of sufficient dimensions not only to contain it, but coals as well for the entire voyage, for if stowed in a sailing vessel and towed by a steamer, the ship becomes in a heavy sea unmanageable, and in case of a hitch occurring, it is almost impossible to check her progress in time to prevent accident. A cable long enough to span the Atlantic will weigh at least 6,000 tons; and when coals must be carried, and in addition a clear space provided sufficient to enable this enormous length of cable to be coiled, it is evident that no existing vessel, except the Great Eastern, would be equal to the requirements of the case. The hands employed in liberating the cable coiled in the hold have a difficult task to perform, even when the sea is calm and everything goes on smoothly. When at full speed, the coils have to be carefully liberated,

layer by layer, from the lashings and packings of wood, so as to set free only as much of the cable as is required, so as to avoid the possibility of its escaping from the guides on receiving any check. The break is a part of the apparatus which requires the most delicate handling; the strain which it puts on must be sufficient to prevent the cable from running out with too great a velocity in proportion to the speed of the vessel, whilst it must be sensitive to every pitch and roll, in order to prevent the cable from being snapped by a sudden strain. Many self acting breaks have been proposed, but in practice nothing has been found so effectual for the regulation of the strain as constant personal superintendence. The speed at which the paying-out vessel travels should be as uniform as possible throughout the whole voyage, and as provision must be made for contrary winds and rough weather, a large amount of surplus power is indispensable. In fair weather it is not difficult to attend to all these precautions, nothing but proper care and attention being necessary; but in stormy weather, when the vessel is tossing to such an extent that the men can scarcely stand while unlashing and freeing the cable, when the pitching of the ship throws sudden and violent strains upon the break, and when the breaksman himself can scarcely keep his feet and can see nothing in the darkness, the difficulty of managing the apparatus properly is of no ordinary kind.—*The Quarterly Journal of Science.*

5. *Permeability of Iron.*—Our readers may recollect our having, some months ago, mentioned certain experiments made by MM. H. Sainte-Claire Deville and Troost, from which it appeared that, by a kind of endosmosis scarcely to be suspected in the case of a metal, hydrogen would pass through the pores of a platinum tube. Last week, the Academy of Sciences received from them a new paper, in which they announce a similar property in iron. The great difficulty was to find a tube answering to the various conditions required for the experiment. The best iron to be found in the markets might still be open to some objection, since in point of fact it is a mere sponge flattened by a hammer, like common platinum. They succeeded at length, through the kindness of a friend, in obtaining a tube of cast steel, containing so little carbon that it did not admit of being tempered. It was in reality rather iron than steel, and so soft that it was drawn into a tube without heating or soldering, though its sides were of a thickness of from three to four millimetres. To the ends of this tube, two other tubes of a much smaller diameter, and of copper, were soldered with silver; the whole was then introduced into an open porcelain tube, which was put into a furnace; a glass tube, luted to one end, established a communication with an apparatus generating hydrogen completely deprived of atmospheric air; while at the other end, another glass tube, bent at right angles, dipped into a mercury bath, its vertical branch being 80 centimetres long. For the space of eight or ten hours, a current of hydrogen was driven through the apparatus, which was maintained at a high temperature, so as to exhaust the action of the hydrogen on the sides of the iron tube, and to drive away all the atmospheric air, as well as the moisture contained in the tube, or likely to be produced there. This done, the communication between the iron tube and the hydrogen apparatus was cut off by melting down the glass tube by the aid of the blowpipe. No sooner was this effected, than

the mercury, no longer kept down by the stream of hydrogen, yielded to the pressure of the air, and rose in the vertical glass tube to the height of 740 millimetres, or very nearly the usual barometrical height. This would not have happened, had there not been a nearly complete vacuum in the tube the instant the supply of hydrogen was cut off. But what had become of the hydrogen supplied before? There is but one explanation possible, viz: that, notwithstanding the pressure of the atmosphere, the hydrogen had passed through the pores of the steel tube. Hence an iron tube introduced into a furnace where there are reducing gases, is a most powerful instrument for carrying off all the hydrogen.—*Galignani.*

6. *Submarine Volcano in the Mediterranean.*—Letters from Malta mention an extraordinary convulsion of nature not far from that city, between the island of Pantellaria and the town of Sciacca, on the coast of Sicily, a submarine volcano having broken out about twenty-five miles from the shore. It is said that a volcano existed there in the year 1701, and on an old chart there is an old reef laid down precisely on the spot where the volcano now is. It was first indicated by smoke rising from the sea about the 12th of August last, which gradually increased in volume for several days till fire was seen, and eventually a small island was thrown up above the surface, about eighty or ninety yards long and twenty or thirty high, composed of cinders. In its centre was the crater, which continually emitted steam and smoke; and during the eruptions, which occurred on an average every hour and a half, large stones and cinders were thrown to the height of one thousand feet. It is mentioned as a singular circumstance that about the same time that this volcano first showed itself, a strong earthquake took place in the island of Samos, which divided a hill into two parts, leaving a valley with a stream of water flowing through it. Recently a party of curious persons visited this wonderful island, and one of them thus reports the result of their observations:

"The beach, which appeared to be a mixture of ashes and sand reduced to a powder, was as hard as the firmest sand, but very few yards from the water-side the surface was extremely rough, composed of loose cinders of all sizes heaped lightly together, so that at every step we sank over shoes in cinders very hot to the touch. Our first object, of course, was to get up the flagstaff, planted by the crew of a British vessel on the summit, which we accomplished after a steep climb up the sliding ashes. When on the top we were nearly to leeward of the crater, and the consequence was that the volume of steam that rose from it drove full in our faces so strong a sulphurous vapor as to make several of the party, including myself, very nearly sick. The part on which we were was then the highest, and seemed on a rough computation to be about two hundred feet above the sea. The crater was some distance below us, round, and perhaps thirty or forty yards across. The level of the water in it was from twelve feet to twenty feet below the lip or highest edge of the actual crater. It was much discolored and boiling strongly, throwing up quantities of white steam, with this sulphurous vapor which annoyed us so much. There was apparently an underground rush of boiling water from the southeast side into the sea, which might be traced a long way

by its dark color, and at the same place a thick volume of steam rose from the outside of the original crater, as if a new one were forming. After staying some time upon the top, we went down again to the crater, and having examined it adjourned to our boats, and pulled round the south side, so as to command a view of the rush of water before mentioned, which came from the island, boiling and foaming, and throwing up a quantity of white vapor and steam. Nothing can be more singular than the appearance of this mass of ashes in the middle of the sea. You may form some idea of the force of the fire that must have been required to form it, by considering that it is, as near as could be estimated, three-quarters of a mile round, and that, where it now stands, former charts give soundings in one hundred and thirty fathoms, and from the soundings lately made, it seems to stand on a large base."—*Evening Post, Nov. 13th*, 1863.

7. *Water in Paris.*—While the waters of Champagne are being conveyed to Paris, and a powerful hydraulic machine is being constructed at St. Maur in order to make the Marne contribute its water to the capital, a new Artesian well is being bored in the 18th arrondissement (Montmartre), under the direction of MM. Degoussée and Laurent. An enormous borer, weighing 5,000 kilogrammes, and provided with six blades of cast steel, has been prepared for this operation. The steam engine which is to set this formidable borer in motion is of 120-horse power. One of the great difficulties to be conquered is a thick stratum of loose sand, which has no more cohesion than water, and falls in as the hole descends. It is in order to be able to force the tubes in before the hole is thus blocked up, that such a powerful engine is necessary. A cylinder of sheet iron, provided with a valve, constructed according to a new system, is used to get the sand and rubbish out. This well, which is expected to reach a depth of 900 metres, is situated on the Place Hébert, near the junction of the Northern and Eastern railway lines, and not far from the gas works of La Villette. Meanwhile, the works for deriving water from the Dhuys are actively progressing. The vast cisterns which are to receive it are in course of construction on the heights of Ménilmontant, at the place called Parc St. Fargeau; and the preliminary operations at Saint Maur have been begun. To avoid the circuit of about 15 kilometres which the Marne fetches between Joinville-Le-Pont and Charenton, Napoleon I. caused a canal, two kilometres in length, half of which is tunnelled, to be dug near St. Maur. Here stand the mills of St. Maur, which are to be replaced by a hydraulic machine, throwing about 40,000 cubic metres of water in the course of 24 hours. These mills are set in motion by falls of water three metres in height by eight in breadth, and fed by the waste water of the canal, distributed between two mill-dams, one on each bank of the river. The eastern one is provided with a machine for feeding the artificial rivulets of the Park of Vincennes. It consists of two pumps set in motion by a strong turbine, and affording 5,000 cubic metres of water in 24 hours, for the sum of 13,000fr. a year. It is this moderate cost which has induced the municipality to supply the east of Paris with water from St. Maur.—*Galignani.*

8. *Academy of Sciences.*—The following are the principal prizes proposed for this year and the following ones, by the Academy, at its last public

sitting; the papers in all cases to be sent in headed by some motto, to be repeated on a sealed envelope containing the name of the author. The dates in parenthesis indicate the last day on which the papers may be sent in. A prize of 3,000 francs is to be awarded to the best paper on the question: "To discuss with care and compare with theoretical results the observations of tides in the principal ports of France" (May 30th, 1865)—3,000fr. "To improve in some important point that part of mathematical analysis which relates to the integration of equations with partial derivatives of the second order" (June 30th, 1865)—3,000fr. "To establish a complete and rigorous theory of the stability of equilibrium in floating bodies" (June 30th, 1864)—6,000fr. "To invent and demonstrate some considerable improvement in the application of steam to vessels of war" (October 30th, 1864)—3,000fr. Bordin prize: "To discuss some question relating to the theory of optical phenomena, at the choice of the competitor" (June 30th, 1864)—3,000fr. Bordin prize for "some notable improvement in the mechanical theory of heat" (June 30th, 1864)—3,000fr. "On the comparative anatomy of the nervous system of fish" (August 31st, 1864)—3,000fr. "On the production of hybrid animals by artificial fecundation" (Dec. 30th, 1865—3,000fr. "For the improvement of French paleontology, either by showing the anatomical characteristics of one or more types of Vertebrata, and thus affording important data for the study of our Tertiary fauna, or else by treating of fossils which belong to one of the least known classes of that great branch of the animal kingdom"—5,000fr. "To give a complete history of pellagra" (March 31st, 1864)—5,000fr. "On the application of electricity to therapeutics" (March 31st, 1866)—20,000fr. The Academy and Emperor's prize, "For methods of preserving members by preserving the periosteum" (March 31st, 1866). Lastly, the Bréant prize of 100,000fr. for the discovery of an unquestionable specific against cholera, or, in default of this, a prize of 4,000fr. to the competitor who can prove that there exist in the air substances which may materially contribute to the propagation of epidemic diseases.—*Galignani.*

9. *Spanish Scientific Expedition.*—A scientific commission has been sent out by the Government of Spain, which will visit most of the countries and localities of interest in the Pacific ocean. The squadron, which comprises several war vessels, arrived at Montevideo, Buenos Ayres, S. A., in December last, from which point the naturalists went overland to Valparaiso, where the fleet was ordered to meet them. We do not know the destination of the expedition after leaving Valparaiso, but as it is not unlikely that this group (Sandwich Ids.) will be visited soon by them, we place in our columns a list of the savans engaged in this commission, which has been kindly furnished to us:

Don Patricio Paz Membiola, President.

Don Fernando Amor, Professor of Natural History, who will attend to mineralogy and entomology.

Don Francisco de Paula Martinez, Professor of Natural History, who will give his attention to fishes, crustacea and mollusca.

Don Marcos Jimenez de la Espada, 1st inspector of the museum for natural sciences, who attends to the mammalia, birds and reptiles.

Don Manuel Almagro, M.D., who has to attend more particularly to anthropology.

Don Bartolôme Puig, M.D., naturalist, who is to assist in preparing and preserving the collections.

Don Juan Isern, 2d inspector of the museum, naturalist, who will attend to botany.

Don Rafael Castro, photographer and draftsman.—*Sandwich Island paper.*

10. *Vegetable Ivory.*—Vegetable ivory, in contact with concentrated sulphuric acid, takes a splendid red color, almost equal to magenta. At first it is pink, but gradually becomes deeper until it attains a purple, when the acid has been allowed to act for twelve hours.

11. *Expedition to the Desert of Sahara, under Messrs. Martins and Escher von Linth.*—A brief notice of the starting of this expedition is given at page 146 of this volume. Mr. Desor, who was one of the party, states in his letters, published in the Swiss journals, that from Biskra their course lay nearly due south to Tougourt, "a Saharian city built of earth so slightly held together that a day's rain would cause half the houses to crumble." Thence they went west to El Oued, returning north by Melriz to Biskra and Constantine. The detailed map of Duveyrier's journal, recently published in *Petermann's Mittheilungen*, (1863, ix,) will be found convenient in tracing this route. The time passed in going from Biskra and returning was about three weeks. Although brief, Mr. Desor regards the expedition as having accomplished important results. His attention was especially directed to the geological age of the Sahara; and he concludes, with Escher von Linth, that it was a vast sea at the commencement of the present epoch, and that only recently has it become dry. He is established in this opinion by the frequent occurrence of a marine shell, the *Cardium edule*, found to-day on the shores of the Mediterranean. Mr. Desor is of the opinion that the elevation of the Desert above the sea though a recent was not a sudden occurrence, but was gradual and marked by successive steps. The party brought home a number of fish from the Artesian wells of the Desert, belonging to the family of *Cyprinodonts.*

12. *Periodical Meteors.*—R. P. Greg, Esq., of Manchester, England, communicates the following to the Committee of the Connecticut Academy on the subject of periodical meteors. The facts are deduced from his own repeated observations and those of A. Herschel, Esq., in England, of Prof. Heis, in Germany, and Schmidt, at Athens.

"The meteors of August last," he states, "were unusually fine and abundant, and those of November increasing from year to year, and more frequent in *horary* numbers on the 14th than the 13th.

"The *second of January*," he remarks, "is a most notable meteoric period of only 24 hours duration, and giving, for several hours, as many as for August 9th–10th. Mr. Herschel and myself mapped each about 60 meteors in two hours. The radiant is about the head of Bootes."

The 9th–15th of February, radiant in Leo Minor; the 6th–10th of March, a recurrent period for a moderate number of large bolides and small shooting stars having their velocity *very* moderate, radiant the head of Lynx; the 5th–13th of December, (having been of late years a fine shower), radiant half way between Alpha Gemini and Beta Aurigæ—are mentioned, together with others requiring observation. He remarks that

the Nov. 13th–14th period is not visible in Australia, according to Prof. Newmeyer; but those of Aug. 9th–10th, with other periods, are.

In addition to the above, Mr. Greg has commenced an extract from the proceedings of the British Meteorological Society, of an important paper by Alexander Herschel, Esq., concerning the meteors of Aug. 9th–10th, 1863, based on observations made at five stations—the Greenwich and Cambridge observatories, the Cremston and Euston Road observatories, and Hawkhurst; it gives the heights, paths, brilliancy, directions, and *estimated mass* of twenty observed meteors of that period. Their average upper limit was 82.50 miles, and their average disappearance was at 58 miles above the sea-level. The former heights varied from 55 miles at the lowest, to 131 miles at the highest; the latter heights varied from 35 miles at the lowest, to 84 miles at the highest. The paths varied, in absolute length, from 18 miles to 100 miles, and averaged 47·5 miles; and the durations varied from half a second to three seconds, and the velocties range all the way from 23 miles to 71 miles a second. The radiant was near Gamma Persei.

An attempt was also made to estimate the masses of the individual meteors by the heat developed—taking the apparent *light* as its measure, and comparing the latter with the amount of coal gas which would yield the same at given distances, and by using the velocity as an additional element to determine the mechanical equivalent of heat. The average mass is put at near one and a-half pounds avoirdupois, varying from 20 grains to 7½ pounds.

It is scarcely necessary to remark here that this last determination must have required a large amount of assumption, and can be received only as an approximation of the rudest description. Even as such, however, it possesses great interest and value. A. C. T.

13. *National Academy of Sciences.*—Titles of memoirs read and of oral communications made at the January Session, 1864, at Washington:

1. The elements of the mathematical theory of quality. First Memoir; Benjamin Peirce.

2. Reduction of the observations of fixed stars made by J. J. Lepaute d'Agelet at Paris, during the years 1783–5, with a catalogue of the corresponding mean places referred to the equinox of 1800; B. A. Gould.

3. The Saturnian System. First Memoir; Benjamin Peirce.

4. On individuality among animals, with reference to the question of varieties and species; L. Agassiz.

5. On the metamorphoses of Fishes; L. Agassiz.

6. On the geographical distribution of Fishes, as bearing upon their affinities and systematic classification; L. Agassiz.

7. Discussion of Magnetic Observations made at Girard College Observatory in the years 1840–45; Parts IV, V, VI. Horizontal Force; investigation of the eleven year period of the solar diurnal variation and annual inequality, and of the influence of the moon. Abstract; A. D. Bache.

8. Discussion of Magnetic Observations, &c.; Parts VII, VIII and IX. Vertical Force; investigation of the eleven year period of the solar diurnal variation and annual inequality, and of the influence of the moon; A. D. Bache.

9. On the force of fired gunpowder, and the pressure to which heavy guns are actually subjected in firing; F. A. P. BARNARD.

10. Description of an anemograph, designed for the University of Mississippi; F. A. P. BARNARD.

11. On materials of combustion for lamps in Light Houses; JOSEPH HENRY.

12. On the Parallelogram of Forces, and on virtual velocities; T. STRONG.

13. On photographs of the Solar Spectrum; L. M. RUTHERFURD.

14. On the tangencies of Circles and Spheres; J. G. BARNARD.

15. Observations of the Planet Venus near the times of her inferior Conjunction, Sept. 28, 1863, and subsequently; Prof. STEPHEN ALEXANDER.

16. Brief note on the forms of icebergs; Prof. STEPHEN ALEXANDER.

14. *Maury's Sailing Directions, and Wind and Current Charts.*—These publications having been submitted by the Navy Department to the National Academy of Sciences for a Report upon their merits and the desirableness of continuing their publication, the subject was reported upon at its late meeting, by a committee which had been appointed for the purpose, and the following resolution adopted: *Resolved* by the National Academy of Sciences, that in the opinion of this Academy, the volumes entitled "Sailing Directions" heretofore issued to navigators from the Naval Observatory, and the "Wind and Current Charts" which they are designed to illustrate and explain, embrace much which is unsound in philosophy and little that is practically useful, and that therefore these publications ought not to be issued in their present form.

OBITUARY.

WM. J. TAYLOR.—Prof. William J. Taylor died at Philadelphia, April 6th, aged 31. He was for several years a resident of Philadelphia, and was an active member of the Philadelphia Academy of Sciences, contributing to the Proceedings of the Academy many important papers in the department of Mineralogy. In the autumn of 1859, he was called to the chair of Chemistry in the Medical College at Mobile, Ala., where he spent but one season. Returning north, he settled near Berlin, Worcester Co., Maryland, and, on the breaking out of the war, was a very ardent supporter of the cause of the Union. He aided in raising a regiment, of which he was Major, and continued in the military service for several months. In his early death, mineralogical science loses an active and able investigator, and Maryland an earnest and whole-souled patriot.

V. MISCELLANEOUS BIBLIOGRAPHY.

1. *Boston Journal of Natural History:* Vol. VII, No. 1, 1859.—ART. I. A Supplement to the "Terrestrial Mollusks of the United States;" by W. G. BINNEY.

No. 2, 1861.—ART. II. Observations upon the Geology and Paleontology of Burlington, Iowa, and its vicinity; by CHARLES A. WHITE.—III. On the Hymenoptera of the genus Atlantus in the United States; by EDWARD NORTON.—IV. Descriptions of new species of Crinoidea from the Carboniferous Rocks of the Mississippi Valley; by JAMES HALL.

No. 3, 1862.—Art. V. Notes on new species of Microscopical Organisms, chiefly from the Para River, South America; by Loring W. Bailey.—VI. Contributions to the Comparative Myology of the Chimpanzee; by Burt G. Wilder.—VII. On Alternate Generation in Annelids, and the Embryology of *Autolytus cornutus;* by A. Agassiz.—VIII. Materials for a Monograph of the North American Orthoptera, including a Catalogue of the known New England Species; by Samuel H. Scudder.

No. 4, 1863.—Art. IX. Observations on the summit structure of Pentremites, the structure and arrangement of certain parts of Crinoids, and Descriptions of new species from the Carboniferous Rocks at Burlington, Iowa; by Charles A. White.—X. Descriptions of the Fossil Plants collected by Mr. George Gibbs, Geologist to the United States Northwest Boundary Commission, under Mr. Archibald Campbell, United States Commissioner; by Dr. J. S. Newberry.—XI. On Arachnactis brachiolata, a species of floating Actinia found at Nahant, Massachusetts; by A. Agassiz.—XII. Prodromus of the history, structure, and physiology of the order Lucernariæ; by Prof. Henry James Clark, of Harvard University, Cambridge, Mass.—XIII. Monograph of the genus Callinectes; by Albert Ordway.—XIV. On the Fossil Crab of Gay Head; by Dr. William Stimpson.—XV. On Synthetic Types in Insects; by A. S. Packard, Jr.—XVI. Description of a "White Fish" or "White Whale" (Beluga borealis Lesson); by Jeffries Wyman, M.D., Prof. of Anatomy in Harvard College.—XVII. Remarks on some characteristics of the Insect Fauna of the White Mountains, New Hampshire; by Samuel H. Scudder.

2. *National Almanac and Annual Record, for the year* 1864. 642 pp., 12mo. Philadelphia, 1864. George W. Childs.—The National Almanac for 1863 was noticed by us early last year (xxxv, 465). The volume now issued sustains the same high character, and besides is much increased in value by a still wider range of subjects, and fuller details. While remarkably complete as a *national* work, it also contains much information on foreign countries, their sovereigns, governments, areas, populations, finances, armies, navies, commerce, navigation, etc. etc.

Astronomical and Meteorological observations made at the U. S. Naval Observatory during the year 1862, Capt. J. M. Gilliss, U. S. N., Superintendent. 700 pp., 4to. Washington, 1863. Published by authority from the Hon. Secretary of the Navy.

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Index Geographicus, being a list, alphabetically arranged, of the principal places on the globe, with the countries in which they are situated, and their latitudes and longitudes; compiled with special reference to Keith Johnston's Royal Atlas. 676 pp. large 8vo. London and Edinburgh.—Wm. Blackwood & Sons. 21*s*.

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[The following were received too late for further notice in this number.—EDS.]

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